Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.S., and E. S. GREW, M.A.

VOL. VI. No. 11. [NEW SERIES.] NOVEMBER, 1909. [Entered at Stationers' Hall.] ONE SHILLING NET.

The Transformations and Migrations of Eels.

By J. T. CUNNINGHAM, M.A., F.Z.S.

IT is surprising to notice what a long time it takes for new discoveries about the most familiar things to become generally known and appreciated in spite of the facilities which now exist for the diffusion of knowledge. I have just read in the *Daily Mail* a letter to the Editor informing the public that in the river Severn there is a tiny fish called the elver, which is eaten with pepper, salt, and vinegar, and considered a great delicacy; that it is said by some to be a young eel and by others to be a distinct species, and that being very prolific it is very cheap. It is not difficult to prove that elvers are young eels, and it has been known to naturalists for a long time that in the Severn and other rivers of Europe they ascend in countless multitudes in spring, apparently coming from the sea and travelling towards the upper and more inland fresh waters. From the bank they can be seen in dense swarms passing in continual procession and the people of the neighbourhood dip them out in baskets or hand-nets and use them as food. As these slender, flexible, worm-like creatures are able to wriggle their way up vertical surfaces and can live out of water in damp grass, it is easy to understand how not only small streams and ditches, but even isolated ponds and wells may become populated by eels. On the other hand, no adult eels have ever been known to breed in fresh water. The earlier naturalists were unable to recognise their generative organs, and the male organs were first recognised by Syrski at Triest in 1874. The males are smaller than the females, not exceeding a length of 19 inches, while the females may reach a length of 39 inches. The organs of the male examined by Syrski were not in the ripe condition, and with the exception of one male specimen neither males nor females have ever yet been seen with fully developed roes and milts. In the autumn, in places where eels are plentiful, the experience of fishermen shows that there is an extensive migration down the rivers towards the sea, and this conclusion has recently been confirmed by marking specimens in Sweden. One or two very rare cases are known of eels taken in fresh water in which the roes were advanced in development; two of these, taken in Lough Neagh, in Ireland, in January and September, 1895, are preserved in the Museum of the College of Surgeons; considering the enormous numbers of specimens in which the roes are but little developed it is evident that these individuals in a different condition are exceptional and afford no evidence of the spawning taking place in fresh water, although it is a fact that in eels taken in autumn during the downward migration the reproductive organs are somewhat larger than in others. Before the discoveries of recent years had been made, then, it was held as a probable conclusion from the above facts that eels spawned in the sea, and that when the young were sufficiently developed they entered the mouths of rivers and ascended as elvers or eel-fare, while the parents never returned from the sea.

In the course of zoological investigation another clue originally supposed to have no connection with the case has been found to lead ultimately to the solution of the eel mystery. As long ago as 1763 was discovered on the coast of Wales a fish four inches long with small head and transparent, curiously compressed or ribbon-shaped body, which was named Leptocephalus. Since that time other specimens have been taken on British shores which have all proved to belong to the same species, but in the Mediterranean and at the surface of the ocean several other kinds of Leptocephalus were found and were described under different specific names. In 1861 it was first suggested, by Professor Carus, of Leipsic, that the Leptocephali were the young stages or larvæ of other fishes, but he did not connect them with the eel family. It was the American ichthyologist, Gill, who in 1864 first, on purely anatomical grounds, came to the conclusion that Leptocephali were the larvæ of eels, and in particular *Leptocephalus morisii*, the one first discovered, the larva of the Conger. Dr. Günther confirmed Gill's statements concerning the structural agreement, but maintained that the Leptocephali were not normal stages of development, but larvæ which had been arrested in their development and continued to grow; his reason being that fully developed young conger were often smaller than the Leptocephali. Similar views have been put forward in reference to other larval forms, but have in all cases proved to be erroneous, the reduction in size during metamorphosis having been found to be quite a common occurrence. In the case of the Conger the question was set at rest by the actual observation of the transformation of a living Leptocephalus into a young conger; this observation was carried out by M. Yves Delage at Roscoff in Normandy in the year 1886, and the transformation was effected between April 18 and the beginning of July.

The next important step in the progress of these investigations was the identification, among the numerous forms of Leptocephalus which had been distinguished, of the larva of the common eel. This was effected by Grassi and Calandruccio at Catania and Messina on the coast of Sicily in the years 1891-2. It has long been known that Leptocephali are more frequently seen and captured on the coasts of the Straits of Messina than anywhere else, a fact which seems to be due to the proximity of deep water and to the currents and whirlpools for which the Straits are noted. Grassi and Calandruccio traced in aquaria the metamorphoses of several kinds of Leptocephalus into different species of the eel family or Murænidæ, and although they were not able to follow the whole process in the case of the common eel they satisfied themselves

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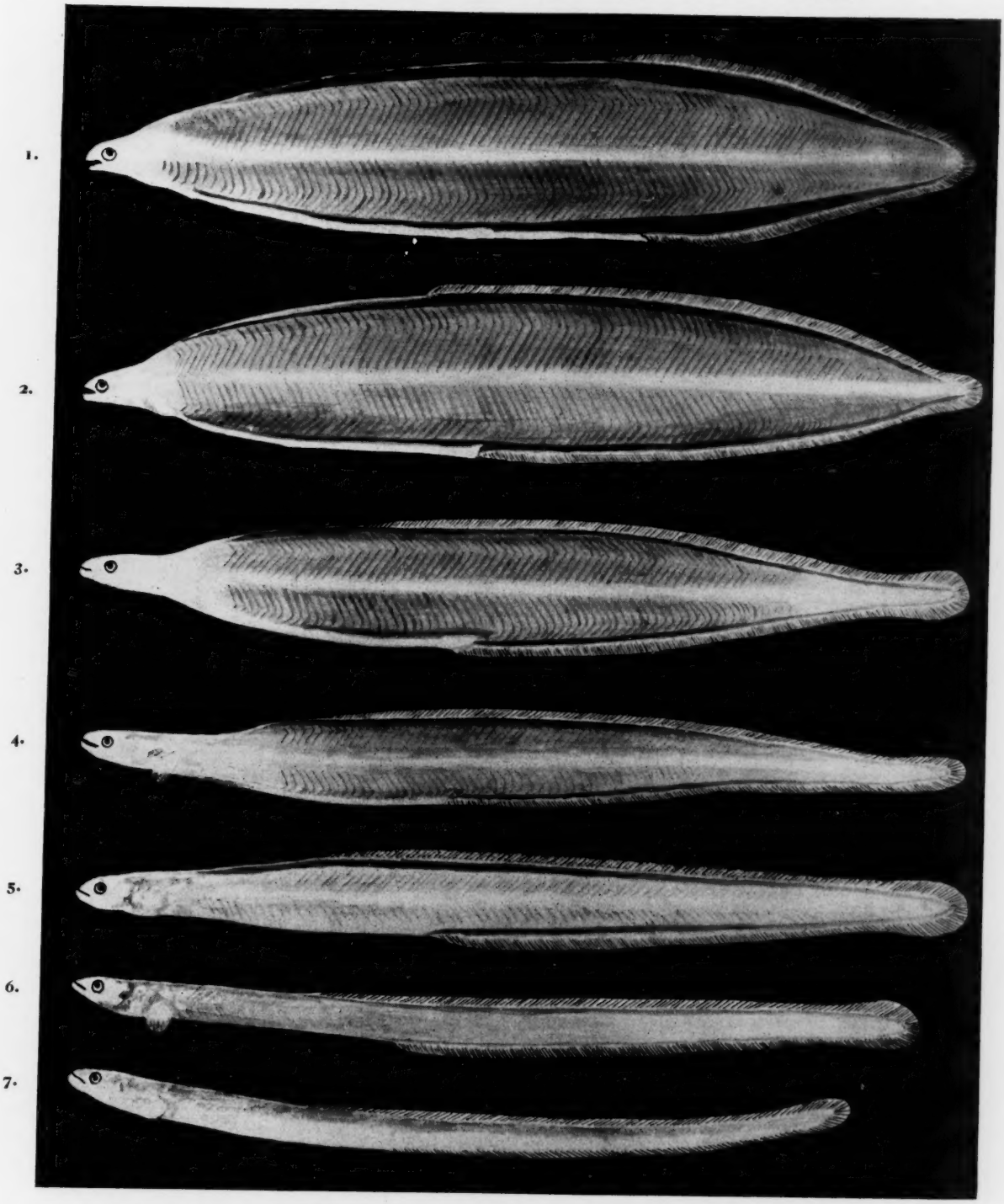
that the larva of this species was a form previously known as *Leptocephalus brevirostris*. This particular form had only been found in the Straits of Messina; it is rather small, not exceeding 8 cm. (3¼ inches) in length and 1 cm. in height. The fully transformed young eel was never less than 5 cm. or 2 inches in length. Besides the larvæ the Italian naturalists obtained specimens of the adult eels with reproductive organs advanced in development, and found that these were distinguished from the ordinary specimens taken in fresh water by larger eyes and by a silvery colour. They concluded from this increase in the size of the eyes and from taking eels and deep sea fishes together that the eels spawn at depths of not less than 200 fathoms. The present writer, commenting on this at the time, pointed out that if it were true for the Atlantic coasts of Europe it would involve a migration of the adults from, say, the mouth of the Elbe to the Atlantic off the west of Ireland, or the Bay of Biscay, and of the young the same enormous distance back again, a journey of about 800 miles each way, while in Sicily such depths occur within a mile or two of the coast. It seemed probable, therefore, that on the west coast of Europe the spawning of the eel might take place at more moderate depths. The recent extraordinary discoveries of the Danish naturalists, however, have proved that eels are actually hatched beyond the 500 fathom line to the west of Ireland or in the Bay of Biscay, and that an eel which may have spent the greater part of its life in the upper part of the Thames or in the Norfolk Broads becomes, when it is sexually mature, a deep-sea fish.

The discovery of the Leptocephali of the eel in the Atlantic by the Danish investigators, in particular by Johannes Schmidt, by whom the actual work was carried out, was not due to accident, but to systematic and reasoned investigation. In the year 1904 the Danish steamer "Thor" was employed in collecting the young stages of edible fishes in the neighbourhood of the Faroes and Iceland, which belong to Denmark. This work was undertaken in connection with the International Fisheries Investigations, which have been going on since 1903. The eel, being of great importance to the Danish fisheries, Mr. Schmidt was naturally anxious to obtain specimens of its larvæ, but, although he used large small-meshed nets both at the bottom and at various depths, he obtained only a single specimen of *Leptocephalus brevirostris*, which was taken in May, 1904, near the surface to the west of the Faroes, at a position where the depth was about 650 fathoms. If the young eels which reach the coast in April or earlier were the offspring of adults which migrated to the sea in the preceding autumn it would follow that Leptocephali would only occur in the winter months, but the Italian investigations showed that they occurred throughout the summer. It might also be that the larvæ were not free-swimming, but buried themselves in the sea bottom, but the fact of the single specimen being taken near the surface made this improbable, and it was concluded that the larvæ must be sought in more southern latitudes. Accordingly, in 1905, from May to the end of June, the "Thor" made a voyage from the north southwards along the west of Scotland and Ireland, following the 500 fathom line, and Leptocephali were taken in increasing numbers till positions were reached off the entrance to the English Channel, where they were found to be most abundant, as many as 80 being taken in a two-hours' haul. Farther south again above similar depths in the Bay of Biscay few were taken. The larvæ were found to be most abundant at a depth of about 50 fathoms from the surface, but were nearer the surface at night than in the daytime. These results proved that the greatest number of eels spawn in the deep ocean off the mouth of the English Channel, and indicate that the adults in their migration from the coasts bordering the North Sea pass chiefly through the Channel to reach the ocean.

In September a few specimens were taken to the west of St. Kilda, and these were found to be in process of metamorphosis. The young eels, after the transformation is complete, are still quite transparent, and they make their way to the coast and enter the rivers. The ascent takes place earlier in places nearer to the Atlantic and also the young eels in such places are more numerous; thus we have the explanation of the elver fishery in the Severn and other rivers entering the Bristol Channel. Similar ascents and similar fisheries occur on the Atlantic coast of France, becoming earlier as we pass from north to south, while, on the other hand, in more northern countries, as Holland and Denmark, the ascent is later, taking place chiefly in April, May, and June. In 1906 the "Thor" made another voyage along the borders of the Atlantic basin to the west of Europe and found the Leptocephali in considerable numbers farther to the south in the Bay of Biscay, but here, as the sea bottom slopes more rapidly, they were captured at a shorter distance from the coast; this was especially the case along the north coast of Spain, where the 500 fathom line is quite close to the coast. In August and September larger numbers of more advanced specimens were obtained, and it was proved that these occur somewhat nearer to the coast than the earlier stages.

The occurrence of eel larvæ has naturally not been so completely followed in the winter months, but the fact that perfectly transparent cylindrical forms occur in the sea a little earlier than the time at which the elvers ascend rivers has been fully established; in the Channel off Cape Grisnez Professor Gilson, at the beginning of February, captured from 100 to 200 at a single haul, and in March and April they have been taken in numbers in the Skager Rack, north of Denmark. From the large number of specimens which have been captured by Schmidt it is easy to trace the course of the metamorphosis, the essential points of which were already known from the work of Grassi and Calandruccio. In Figs. 1 to 7 are shown the successive stages. These figures are copied from Schmidt's photographs which were taken from the actual specimens after preservation in formalin; each specimen is of the average size of the stage it represents, so that the reduction in length and height which takes place during metamorphosis is correctly shown in proportion to the size of the figures. The average length of the first stage, shown in Fig. 1, is 7.5 cm. or 3 inches; the average length of the fully developed young eel taken in fresh water, represented in Fig. 7, is 6.6 cm. or 2⅗ inches; the total reduction in length is, therefore, very nearly 1 cm. or ⅖ of an inch. The figures show that no reduction in length takes place until the curious change in the form of the body, in other words the reduction in height, has been very nearly completed. With regard to the actual changes of structure and form which take place in the metamorphosis it will be seen from the first figure, which represents the highest development of the Leptocephalus form, that in this the lateral muscles of the body, consisting as in all fishes of a series of muscle segments or myomeres, are much flattened and extended dorso-ventrally. The anus is far back, the intestine extending along the ventral edge through two-thirds of the

The Transformations and Migrations of Eels.



Figs. 1-7.—Stages in the metamorphosis of the Eel, after photographs illustrating Johannes Schmidt's paper in Meddelelser fra Kommissionen for Havundersogelser, 1909. Fig. 1, First Stage; Fig. 2, Second Stage; Fig. 3, Third Stage; Figs. 4 and 5, Fourth Stage; Fig. 6, Fifth Stage, or Glass-eel; Fig. 7, Sixth Stage, young pigmented fully developed Eel. Length of specimen shown in Fig. 1, 7.5 cm. (3 in.), of that shown in Fig. 7, 6.6 cm. (2⅝ in.).

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length of the body. The vertical fin extends round the posterior third of the body, from the anus round the tail to a point on the dorsal edge a little in advance of the anus. Fig. 2, representing the second stage, shows that the first change consists chiefly in the shortening of the intestine and the corresponding extension of the vertical fin; the changes in this direction are only slightly increased in subsequent stages, the dorsal fin especially extending a little farther forward in the final stage. Figs. 3, 4, and 5 show how the reduction in vertical height of the body takes place, proceeding from the head and tail to the middle. Fig. 6 shows the transparent young eel which is still pelagic and has been taken swimming freely, especially at night, near the surface of the sea. One of the most extraordinary facts about this metamorphosis is that the larvæ take no food whatever during the course of it, a period of eight or nine months. In the fifth or glass-eel stage food has been occasionally found in the intestine and some of these young may feed on their way to the more distant coasts, but the fact that the perfect pigmented stage represented in Fig. 7 is smaller than the transparent stage shows that no growth has taken place, but a continued reduction. Schmidt made a comparison between the average weight of the Leptocephali in stage 1 and of the glass-eels in stage 5, and found that, during the transformation, the Leptocephalus lost over 77 per cent. of its weight. It might be that this was merely a loss of water and was due to the consolidation of the tissues, but comparison of the weights of the dried specimens showed that the loss of dry weight was over 32 per cent., so that, although the reduction in size is partly due to contraction of the tissues, there is also an actual consumption of material as the necessary result of so long a period of fasting. The actual weight is indicated by the following figures: On the average 691 Leptocephali in stage 1 weigh a kilogram, while it takes 3,112 glass-eels in stage 5 to make the same weight, or in English weight a little over 2 lbs.

IN disclosing to acquaintances what he believed to be some of the causes of long life, the late Sir Isaac Holden, after dilating on the advantages of bananas as a food, used to conclude: "and, above all, not too many baths; they are weakening." This recondite observation is recalled by some remarks by Dr. Remlingen, which are quoted in *Cosmos* on the infective dangers of water, even when used externally. Dr. Remlingen has found several instances of boatmen who have contracted typhoid or cholera when their work has taken them into contaminated waters. The inference is either that the water has been accidentally swallowed or that it has come into contact with their food. *Cosmos*, which is inclined to make merry over the danger, points out that bathing is evidently an operation attended by the gravest risks, and suggests that the only way to avoid them is never to wash except in water that has been boiled, or, better still, never to wash at all. But the **risks of water contaminated by the Eberth bacillus of typhoid** are not wholly imaginary. A very curious instance of infection is described in the *Journal de Medicine et de Chirurgie Pratiques* (September). The regiment of the 11th Dragoons was stationed near the Savoureuse, a river fitly named, which waters a typhoid infected valley. The river was so unsavoury that the men never bathed in it; but the horses were daily groomed on its banks. The horses after being walked in the pools of the river, which was nearly dry at that time of year, were groomed and taken back to camp. The implements of their toilet were usually kept in the nosebags, and a good many of the troopers who took a piece of bread with them to eat on the way back were in the habit of putting this also with the brushes. An epidemic of typhoid in the regiment was most clearly traced to this cause, and the epidemic ceased when the use of the river was stopped.

A Model of the Solar System.

By AGNES FRY.

THE difficulties of astronomy as a school subject are obvious unless, indeed, it is simply to be studied out of text-books, in which case the "divine science" may become almost as dry and worthless as anything else. Actual observation of the sun cannot be arranged for the time-table, the "wandering moon" is seldom in the sky when she is wanted, and the planets and stars avoid school hours altogether. And yet if, as has been said, astronomy is the science which will most help to release the human spirit from its fetters, it is to be lamented that an acquaintance with its elements is not as universal as reading, writing, and arithmetic, and that the constellations are less familiar to most educated people than the names of the kings of Israel.

I have lately designed a model which might well be made by the upper classes in any school, and which would bring home to their minds better than pages of figures the relative sizes and distances of the members of the solar system and the extraordinary rarity of

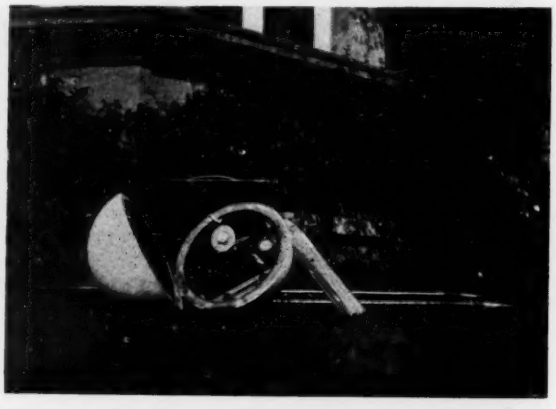

Fig. 1.—Showing Planets inside the Sun.

what we call matter in the sea of ethereal space. Not only could this model be easily constructed by children, but the actual figures of the solar system being supplied to them, they could easily work out for themselves the relative sizes of the planets and satellites for the model. I find the most convenient scale to be one foot to one million miles; not only because this is so easy to work and to remember, but also because it is the smallest scale on which it is possible to represent the smaller satellites with any approach to accuracy. The scale is, however, something of a compromise between accuracy and convenience, for it is not possible to show Mars' moons (9 and 11 miles in diameter) truly to scale; while the ½-mile distance at which Neptune ought to stand requires more ground than is easily available. But a much smaller space, within the limits of an ordinary playing-ground, is sufficient to exhibit the sun and the four nearest planets, and from this alone a very good idea of the whole may be formed.

As it is not easy to obtain all the elements of the solar system without reference to recent astronomical works, I subjoin the figures. I will give an account of the model afterwards. I am indebted to Mr. Crommelin, of Greenwich Observatory, for some of the recent measurements most kindly supplied by him.

	Actual Size in Miles.		Size of Model on Scale, 1 ft : 1 million miles.	
	Diameter.	Distance from Primary.	Diameter.	Distance fr. Primary.
Sun	800,000		10⅔ in.	
Mercury .	3,000	36 million	1/25 ,,	36 ft.
Venus .	8,000	67 ,,	1/10 ,,	67 ,,
Earth ..	8,000	93 ,,	1/10 ,,	93 ,,
Moon ..	2,000	240,000	1/40 ,,	3 in.
Mars .	4,000	142 million	1/20 ,,	142 ft.
Phobos..	11	6,000	A mere speck	1/14 in.
Deimos..	9	14,000	,, ,,	1/8 ,,
Jupiter ..	88,000	484 million	1 1/25 in.	484 ft.
5th Moon	120	112,000	A mere speck	1½ in.
10th ,,	2,200	267,000	1/40 in.	3 ,,
Europa	2,000	425,000	1/40 ,,	5 ,,
Ganymede ..	3,000	678,000	1/25 ,,	8⅓ ,,
Callisto..	2,500	1,193,000	1/30 ,,	14½ ,,
6th Moon	100	7,115,000	A mere speck	7 ft. 1½ in.
7th ,,	35	7,300,000	,, ,,	7 ,, 3 ,,
8th ,,	35	15,000,000	,, ,,	15 ft.
Saturn .	74,000	887 million	9/10 in.	887 ft.
Mimas .	1,000	120,000	A mere speck	1½ in.
Enceladus ..	?	155,000	,,	1⅘ ,,
Tethys ..	500	191,000	,,	2⅔ ,,
Dione ..	500	246,000	,,	3 ,,
Rhea ..	1,200	343,000	,,	4 ,,
Titan ..	2,500	796,000	1/30 in.	9⅔ ,,
Hyperion	?	1,000,000	A mere speck	1 ft.
Japetus..	1,800	2,400,000	1/40 in.	2 ft. 4⅘ in.
*Phœbe ..	150	8,000,000	A mere speck	8 ft.
Uranus ..	33 000	1,783 million	2/5 in.	1,783 ft.
Ariel .	500	123,000	A mere speck	1½ in.
Umbriel	?	171,000	,,	2 ,,
Titania .	?	281,000	,,	3⅖ ,,
Oberon .	?	376,000	,,	4⅘ ,,
Neptune.	37,000	2,800 million	2/5 in.	2,800 ft.
Triton ..	2,500	220,000	1/30 ,,	2⅔ in.

* A tenth moon, Thetis, has been suspected, but its existence is doubtful. If actual, its distance is about equal to Hyperion's: its size uncertain.

In the model I am describing the sun is a wooden ball, it opens with a lock and key, and the planets, on little stands, are packed inside it. But it is also quite easy to make a ball the required size of calico, and stuff it with hay, but in any case sunspots to scale should be painted on it to show their size in relation to the planets. They should be dark spots of about 1/12 in. in diameter, surrounded by a penumbra of 1/6 in. in diameter. It is not difficult to get a good picture of some of the large ones that have appeared lately. The sun should stick on a pole about 4 ft. high, or, if made of calico, it can hang from the top; at the distance of 36 ft. another stake must be fixed, and on this Mercury will stand. A pin-head of the right size run into a stick will do, but where carpentry is available something neater and more permanent will no doubt be fashioned. In my model the planets are on stands which screw to the tops of the poles. Venus will be similar to Mercury, but larger; the Earth and Moon can be arranged on one stand fitted to a single pole or on two closely neighbouring poles. And if the sizes and distances have been carefully executed it will be found that the model moon placed between the Earth and the Sun does exactly eclipse the Sun for an eye placed just behind the Earth. We may observe, too, that the model Sun subtends exactly the same angle from the model Earth as the real Sun does from the Earth, and in general that, the triangles being similar, the Sun viewed from each of the model planets looks just the size it would from the actual planet, whence arises a lively sense of pity for any possible Neptunians. Mars' moons are difficult to manage from their minuteness and their nearness to their primary; pins turned business end upwards and tipped with specks of white paint may represent them.

Jupiter's great globe may be made in wood or of

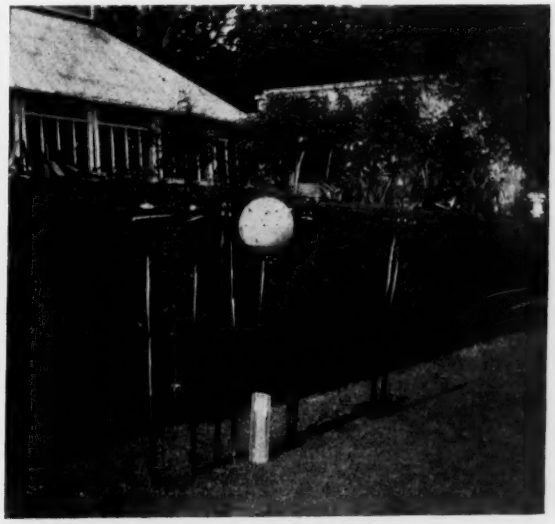

Fig. 2.—Showing Sun and Planets. The distances are not in proportion.

Fig. 3.—The Sun, Mercury, Venus, Earth, and Moon at correct distances.

plasticine, but in either case his polar flattening and his belts and red spot should be studied from one of the easily accessible drawings and clearly represented. His five nearest satellites can be arranged on his stand. Ganymede, it may be noted, is about the size of Mercury, as is also Saturn's Titan. The four large Jovian satellites are the only ones whose discs admit of actual measurement, the size of most moons in the solar system being estimated by the amount of their light. The

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6th and 7th moons discovered a few years ago stand very close together; 20 feet away is the 8th moon, which, as seen from Jove itself, would be a 9th magnitude star invisible to the unaided human eye.

Saturn's rings should be carefully contrived and the different divisions marked upon them. A large field is required to set up as far as this planet, but a good stretch of straight road would probably be required if Uranus at the distance of ⅓ mile and Neptune over ½ mile from the Sun are to be included. There may be some little difficulty in measuring off these distances. I keep a string 484 ft. long wound on a board about a foot long; on the string at intervals are labels indicating the planets up to Jupiter; after this the measurement must begin again, and 403 ft. beyond Jupiter will be Saturn's place. Uranus' distance is twice that of Saturn plus 9 ft.; while Neptune's position may be found by measuring beyond Uranus twice the whole length of string, plus Mercury's distance from the sun, plus 13 ft. by guess. But I fear that the ultra-Neptunian planet—when found—will still have to be left unrepresented. The comets, and the asteroids which occur between Mars and Jupiter, are also omitted.

On this scale a light year will measure 1,100 miles. Hence one realises something of the distance of the

Fig. 4.—Same as Fig. 3.

fixed stars. α Centauri would be in New York, and the nearest star visible in the N. hemisphere, 61 Cygni, reckoned to be 40 billion miles away, will be about as distant as Pekin viâ New York. From which figures, perhaps, some sober views may be obtained concerning the probability of the transmission of germs from one star to another.

Further, if the computation be correct that the farthest stars of the Milky Way are 4,000 light years distant from us, then on the scale of the model these stars will be about 20 times as distant as the real Moon is from the real Earth; but how sparsely the stars are distributed, how rare are these "small islands in ethereal space" we can dimly realise if we accept Lord Kelvin's computation that all the matter in the universe is equal to 1,000,000,000 suns, which, on the scale of the model, means that all the matter in the universe would fill a sphere whose radius would be 800 ft., *i.e.*, 87 ft. short of Saturn's distance from the Sun.

The scale of the model being 1 : 5,280,000,000, we must divide the times of revolution of the planets by the same figure to obtain the years of our models; in other words, if our models are moving at the same *speed* as their prototypes, in what time will they complete their orbits? The figures are somewhat amazing; the Earth would revolve round the Sun 167 times in a second; Neptune would complete his 3-mile orbit in one second; and the Precession of the Equinoxes would be accomplished in about two minutes. Clearly it is impossible to construct any machinery to move our model at the requisite speed, but on this small scale it is easier to realise something of the mighty forces which keep the solar system humming.

On the same scale of time one week will represent the period that has passed since the Archæozoic period, if this be reckoned according to some modern estimates as having begun 100,000,000 years ago.

NOTE.—Models similar to the one described can be made to order by Mr. Henry Bennett, High Street, Portishead, Somerset.

THE last two years have been fruitful in the discovery of remains of primitive man. At the Natural History Museum a case has been recently added which shows the various types of primitive skulls: The *Pithecanthropus erectus* found a generation ago in Java, and presumed to be the oldest direct ancestor of man; the Neanderthal and Spy skulls found in Western and Central Europe; the Moustier skull found in the middle Pleistocene strata of Dordogne; and latest of all the divided jaw-bone found at Heidelberg and supposed by Dr. Schoetensack to be of a type dating from the earliest Pleistocene or even to the late Pliocene, and certainly antecedent to any other European skull. The Heidelberg man is by hypothesis the ancestor of various types of which the Spy man is one; and the primitive Australian type another. M. Florentino Ameghino, of the National Museum of Buenos Ayres, has now published a memoir on a primitive human skull, found in some recent excavations at Buenos Ayres at a depth which warrants the supposition that it dates like the Heidelberg skull, from the late Pliocene. To the type M. Ameghino has given the name *Diprothomo*, and he regards the type as the precursor of the *Homo pampeus*, which is another primitive skull found in the South American Pleistocene. The skull is not complete, but the upper part is nearly perfect, and like the skulls of other primitive men, it discloses what we may call a very shallow brain pan. There is hardly any forehead at all, and the *Diprothomo* would have appeared to have practically no top to its head. M. Paul Combes, in commenting on M. Ameghino's photographs and drawings of the skull, and in his deductions from them, remarks that this discovery like others of less recent date, seems to show that some of the anthropomorphic skulls—like that of the *Pithecanthropus* or of the Heidelberg man—were not men at all, nor the direct ancestors of man. They were merely collaterals, and man has a direct descent through a pedigree not yet completely made out.

BAKER'S SECOND-HAND INSTRUMENTS.—The October list of Second-Hand Instruments which is issued by Mr. C. Baker, of 244, High Holborn, comprises no fewer than 1,329 pieces of apparatus, the approximate aggregate price of which amounts to £6,000. The list embraces microscopes, telescopes, surveying and drawing instruments, field and opera glasses, and apparatus for the determination of time, velocity, heat, pressure, weight, specific gravity, and other constants. The list is a very remarkable one for the variety as well as for the number of the instruments which are offered for sale or for hire, and is of the greatest value to students, or to those who are not prepared to expend the larger prices demanded for first-hand instruments and apparatus.

Hail and its Attendant Superstitions in Italy.

By E. C. VANSITTART.

PRIMITIVE tillers of the soil have always regarded with superstitious terror those forces of Nature which work havoc, obliterating in a few seconds the results of hard labour and patient toil persisted in for weary months, or even years. Of these none is more dreaded than a hailstorm; even at the present day the Italian *contadino*, who is ignorant of physical and scientific causes, regards this scourge as either the outcome of God's wrath at man's wickedness, or as the direct work of the Devil; in either case to be averted by recourse to religious services, incantations, amulets, or other protective symbols.

Professor G. Bellucci, of Perugia, has written an interesting treatise on the superstitions connected with hail in Umbria, to which I am indebted for most of the information contained in this article, though the same belief, in one form or another, holds good throughout the Peninsula.

The conception that hail is sent by God as a punishment of sin, especially that of blasphemy, is very common in Umbria. In some districts, however, other causes are brought forward to account for the scourge; for instance, at Tavernelle, where, during two successive years in April, the crops were devastated by terrific hailstorms, it was attributed to the suppression of the festival of St. George which fell in that month; in another place to the omission of a procession which, from time immemorial, had been made to a mountain shrine on May 1.

When, on the other hand, it is regarded as the work of Satan, the Italian peasant is firmly convinced that it has been induced by an enemy using spells and incantations, or that it is the result of the "evil eye," the *jettatura*, that is, of envy or hatred. Many instances from daily life will be adduced to prove the truth of this assertion, resting on the same grounds that are put forward when it is assumed a child or an animal has been "overlooked." The means employed for averting or arresting disaster are twofold—*preventive*, when regarded as the direct work of Satan; *direct*, when looked upon as the vengeance of God. To the first belongs the habit of putting up a wooden or cane cross in the wheatfields, either 1½ metre high, or else of sufficient height to rise clear above the wheat when full grown; further to strengthen its efficacy against the Evil One's assaults, two sprigs of olive, one of which has been blessed on Palm Sunday, the other on the festival of St. Peter the Martyr, April 29, are affixed to the arms of the cross, or the olive may be replaced by the sheathed leaves of the *giaggiolo* (Florentine iris), whose white or purple flowers are so well known in Tuscany and Lombardy landscapes. Sometimes these leaves are twined round the cross instead of hung from its arms, or else nailed on its structure. In some localities a bit of consecrated candle is also added. The virtue of these symbols, however, does not depend upon themselves; to be efficacious they must be put up and annually renewed on April 29 or not later than May 3, which is Holy Cross Day.

When the corn is cut in the neighbourhood of Perugia the peasant adorns the cross with a bunch of the finest wheat-ears; this is called *fare la carità alla croce*, and is a thank-offering to the cross for having protected the fields from harm. These crosses are afterwards removed to the hayricks to ward off lightning.

In many parts of Umbria branches of olive blessed at one of the dates specified, crosses formed of two iris leaves, or of wood, are attached to the olive or fruit trees. In others, handfuls of ash from the log burnt on Christmas night, small leaves blessed and distributed on the festival of San Nicola di Tolentino, fragments of consecrated tapers, and kindred objects are placed in the forked branches of vines or nailed to the fruit trees. Near Trevi, again, ashes from the Yule log are strewn in the shape of a cross (from a metre to 1½ metre in length) over the newly sown wheatfields, while the custom of placing the skull of a goat or an ass on the top of young trees or vines is very common in the Roman Campagna. On the eve of the Ascension the peasants at Cannara, besides lighting fires in the open fields, are wont to mount to the top of the highest trees on their farms and to call each other loudly by name, in the firm conviction that so far as their voices carry no hail will fall that year.

Nor are armlets and talismans wanting, sufficient in themselves to conjure the dreaded peril. Such are: Oval pebbles of alabaster looked upon as petrified hailstones, a prehistoric flint head set in a heart-shaped casing, a fragment of carbonised wood from the Christmas log, a bit of blessed candle enclosed in the hollow of a bamboo cane, *Agnus Dei* in wax, etc. In mountainous districts medals of San Benedetto are fastened to the trees. Tiny silver bells, hallowed by a special blessing, and distributed at the shrine of the Madonna di Loreto, are held to be specially powerful, since, in popular credence, these tinkling bells, however faint, drive off witches, and even the Devil himself.

Bells, indeed, are supposed to be endowed with special virtue; scarcely does a black cloud appear on the horizon than the village bellringer hastens to the church tower and sets them ringing, with the double object of driving away the hail by the sound of the "sacred bronze," and as a warning to the workers in the fields to watch and pray. Not only church bells, but those hanging in castles and public buildings follow suit, till the air is filled with clangour. Some bells possess greater virtue than others, especially those which have been put up with money contributed by the poor of the parish, those belonging to shrines, sanctuaries, and places of pilgrimage, or such as at their consecration had the names of saints bestowed upon them. This ringing goes by different names in different districts; *suonare ad acqua cattiva, ad acqua triste, a malacqua, a distesa, a tempesta, a scongiuro*, are but a few out of many. In the Roman rite for the consecration of church bells, after they have been sprinkled with holy water, special allusion to their power over evil spirits and against storm and tempest is made. Thus: "O Lord, invest these bells with Thy sovereign might, that at the sound of these sacred bronzes, the fiery darts of the Evil One may be quenched, and hail and storm may be warded off." Again: "When the sound of these bells shall pierce the clouds, may holy Angels descend to rout Satan's hordes, and may they always protect the harvest fields, as well as the bodies and souls of Thy children, O Lord Jesus Christ." In these and similar passages of the Roman liturgy the supernatural power conferred upon church bells at their consecration is most clearly expressed. The Chiesa Nuova, in Rome, is said to possess a stone which, by sweating at the approach of a storm, gives warning to the priests, who, according to traditional usage, immediately set the bellringers to work, and the

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parishioners, hearing the peal, cross themselves, and, kneeling down, repeat certain prescribed collects.

If, however, in country districts the bells have not prevailed and the black cloud continues to advance, stronger measures are resorted to; the *capoccia*, or head of the house, steps out with his gun, charged either with rocket cartridges or leaden projectiles, or even bits of consecrated candles. The guns employed must be those used at religious festivals, specially that of St. Barbara, patroness of hail, December 4, the translation of the holy house at Loreto, December 9 and 10, or on the eve of the Ascension. The object of this firing to ward off hail is expressed by the words *rompere*, or *corrompere l'aria* (to break or corrupt the air), the peasant being convinced that the shock caused in the atmosphere by the gun's discharge will disperse the hail clouds, provided it be resorted to before the hail begins to fall. Others assert that the shots are against evil spirits who have produced the hail, owing to the *jettatura* cast by an enemy. In this pure superstition there hides one of the secrets that so-called progress has won from Nature as verified by scientific test and observation, for it has been proved that the electro-magnetic combinations which accompany, and possibly cause, a hailstorm can be dispersed by the explosion of grenades, or of a charge from an iron mortar or petard. To this end curious funnel-shaped iron machines are to be seen dotted amongst the vineyards on the slopes of the Alban and Sabine hills. They are fitted on to a base firmly embedded in the earth, and when one of the devastating thunderstorms is seen rolling across and up the Campagna, the cartridge is prepared and the charge or charges are exploded at the moment experience has proved to be the most effectual in regard to the position and trend of the storm. Special instructions to this end are issued by the Society for insurance against hail, to which most of the wine-growers of that district belong..

While the *capoccia* is firing his gun the women of the family hasten to carry out of the house the hoe, scythe, spade, and other rural iron implements, the shovel, tongs, and iron chain from which hangs the cauldron (known as *la catena del fuoco*, or *del camino*), the rosary, blessed palm branch, crucifix, and pictures of saints; all these things are spread out on the threshold in the shape of a cross. Prayers are addressed by the older members of the family to San Vincenzo and other guardians against hail. One such used at Braschi is truly ludicrous in its intense selfishness; it runs as follows: "Blessed San Lungino, let it rain without lightning, let it thunder without a particle of hail; at Castiglione yes, at Braschi no. . . . Grant us a drop of water for the poor beans, etc."

Sometimes the priest is called in to avert the threatening storm by the use of special prayers, or fires are lit in the open, blessed palm branches and tapers burnt before the pictures of the saints indoors, the rising smoke being supposed to exercise a potent influence; to these may be added a pinch of salt or fragments of certain small loaves blessed in church on the festivals of special saints, and freely bestowed upon the faithful; such are those distributed in Perugia by the Augustinian Fathers on September 9, the feast of St. Nicholas. These loaves, which may not be sold, generally bear the impress of the saint on whose day they are doled out, and are credited with many virtues, of which protection against hail is only one.

A young child, holding a crucifix or blessed palm branch in one hand, and ringing one of the little bells from Loreto in the other, is made to walk round the house, the whole family following in procession; or the child, with the bell in its hand, is placed outside in front of the storm. In the neighbourhood of Perugia the first hailstone is picked up and laid on the bare breast of a suckling child, and at Casa Castalda a babe is made to swallow it. Holy water is sprinkled over the threshold, and garments—preferably children's—strewn across it. The last and supreme resource is to detach the iron chain that holds the cauldron, and to throw it outside the house door; at the sight of it the Devil is bound to fly, and it is regarded by the peasants as an infallible remedy, only resorted to when all other means have failed, since it is proscribed by the Church, probably because of the connection of the Devil with infernal chains, or because the Almighty is supposed to have enchained Satan!

If we search for the origin of these customs we find that all of them are but survivals of Pagan rites, and can be traced back to heathen times. The planting of crosses in the fields and on the trees is derived from the old pagan custom (proscribed by Charlemagne in 789) of putting up poles in the fields, with fragments of parchment fastened to them, on which were traced magic signs supposed to keep off hail and storm. We have the counterpart of the habit of firing against cloud-storms in a machine constructed by the Emperor Caligula which shot stones for the same purpose. No doubt this practice commonly prevailed, for in Friuli stones are still employed.

Using the ashes from the Christmas log can undoubtedly be traced back to the ceremonies observed in connection with the winter solstice, or solar feast. Throwing out agricultural and domestic utensils is assuredly a survival of propitiatory offerings to the gods, as is the habit of loosening the iron chain. Exposing young children to the storm, making them swallow the first hailstone, casting their garments on the threshold are merely the equivalent for the sacrifice of innocent children or animals made to heathen deities, in the present day unconsciously made, under another and different form, to propitiate Satan, "Prince of the powers of the air," and thus we are once more led to the conclusion that there is "nothing new under the sun."

Star Maps, Calendar, and Almanac.

WE wish again to call attention to the admirable series of publications which are issued by Messrs. King, Sell and Olding, from the "KNOWLEDGE" Office, and which deal with the visible stars of the heavens. These publications are edited by "H.P.H," who is responsible for the Star Maps periodically published in "KNOWLEDGE"; and comprise "The Stars from Year to Year" (1s. net); "The Star Almanac for 1910" (3d. net); and "The Star Calendar for 1910" (1s. net). The first of these publications forms a useful handbook to those who, not being students, yet take an intelligent interest in the constellations. It has a workmanlike introduction and twelve circular charts, showing the arrangement of the constellations in the night sky about the middle of the month. The "Star Almanac," which might well find a place in Public Libraries and Schools comprises four quarterly charts, a calendar, and a vast amount of useful information about celestial bodies, with a special reference to comets. The "Star Calendar" consists of a revolving disc of the constellations with directions for adjusting it to the seasons, and the months of the year; and can be conveniently hung so as always to present a picture of the sky throughout the year. The charts are all well printed, conspicuously accurate, and easy to understand.

New Radium Applicators.

By G. G. BLAKE

THE following are two different forms of radium applicators which I have designed:—Fig. 1 shows an applicator which I had made to my own design by Mr. Armbrecht; A is a piece of ebonite slightly hollowed at the end, and on this 5 milligrammes of radium bromide is mounted with varnish. If the applicator is used in this way with no cover of any sort over the radium it gives off the whole of the Alpha as well as the Beta and Gamma rays, but the applicator is also provided with a set of one mica and five metal discs, any of which can be fastened over the radium by means of a screw cap B.

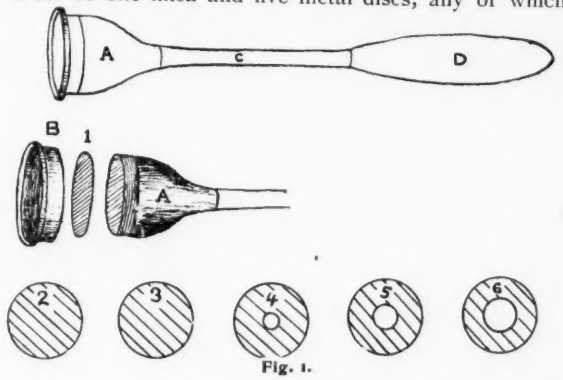

Fig. 1.

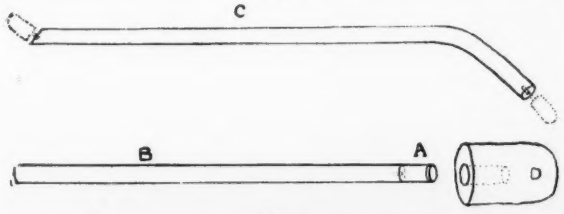

Fig. 2.

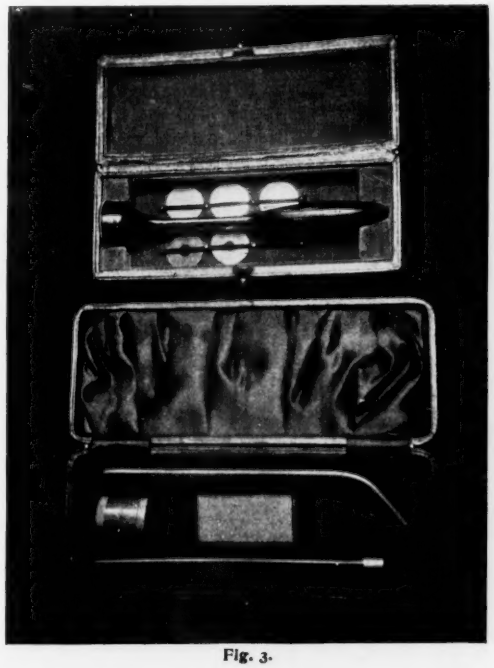

Fig. 3.

The mica disc 1 (which is shown in position ready for screwing on) cuts off all the α rays, but allows practically all the β and γ rays to operate on the patient. Disc No. 2 is made of aluminium and allows about half the β rays and all the γ rays to act on the patient, and disc No. 3 is of lead, of such a thickness as to entirely shut off both the α and β rays, and allows only the γ rays to pass. Discs 4, 5, and 6 are also made of lead, but have holes of various sizes at their centres, and are put in front of the radium when the spot being treated is smaller than the end of the applicator. The ebonite cup A is mounted on a brass stem C, which has an ebonite handle D at its end.

Fig. 2 shows another form of applicator which I had made for me by Messrs. Johnson Matthey and Co. In this case 10 milligrammes of radium bromide (1,800,000 activity) is mounted in a small silver tube A (without the use of varnish) under a small silica window at the end of the tube; the tube is only $\frac{1}{2}''$ long, and is fitted with a screw so that it can be attached at will to the end of a straight ebonite pencil B. For general use, or when used for epithelioma of the throat or tongue it is screwed on to either end of the curved ebonite tube C, as shown by the dotted lines. D is a lead cover which is put over the radium to protect the operator when carrying it about.

Fig. 3 is a photograph of the two applicators in their respective cases. The oblong space shown in the centre of the lower case is a small platinocyanide of barium screen for demonstration.

The Highest Balloon Ascension in America.

MR. LAWRENCE ROTCH writes in *Science* as follows:—Although a large number of *ballons-sondes* were despatched from St. Louis in 1904-7 under the direction of the writer none had been employed in the eastern States until last year. In May and July, 1908, four *ballons-sondes* were launched from Pittsfield, Mass., with special precautions to limit the time they remained in the air and so prevent them from drifting out to sea with the upper westerly wind. Three of the registering instruments have been returned to the Blue Hill Observatory with good records. The first instrument sent up on May 7 was not found for ten months, and the record, forming the subject of the present article, is very interesting because it gives complete temperature data from the ground up to 17,700 metres, or 11 miles. This is 650 metres higher than the highest ascension from St. Louis, which, by a coincidence, was also the first one to be made there. On May 7 a general storm prevailed, so that the balloon, travelling from the east, was soon lost in the cloud and its subsequent drift could not be followed, but the resultant course was 59 miles from the south-west, as determined by the place where the instrument fell two hours later. At the ground the temperature was 4°.5 C., and this decreased as the balloon rose to the base of the cloud, which itself was considerably warmer than the underlying air. Above the cloud the temperature continued to fall with increasing rapidity up to a height of 12,500 metres (nearly eight miles) where the minimum of −54°.5 C. was registered. Here the great warm stratum was entered and penetrated farther than ever before in this country, namely, to the height of 17,700 metres, where the temperature was −46°.5 C. An increase of 8°.9 occurred, however, in the first 3,000 metres, for above 15,500 metres nearly isothermal conditions prevailed, confirming the belief of Teisserenc de Bort that what he calls the "stratosphere" is composed of a lower inverting layer with isothermal conditions above extending to an unknown height. In an ascension last November in Belgium the relatively warm stratum was found to extend from 12,900 metres to the enormous height of 29,000 metres, or 18 miles, where there was still no indication of its diminution.

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Halley.

By J. E. GORE, M.R.I.A.

IN view of the return of Halley's comet, which has now been found by the telescope, some account of the great astronomer with whose name the comet is associated may prove of interest to the general reader.

The great French astronomer Lalande considered Halley to be the greatest English astronomer of his time, and this opinion is certainly just. He was doubtless one of the greatest men of science that England, or, indeed, any country, has ever produced.

Edmund Halley was born in London on November 8, 1656. From his earliest year he applied himself with zeal to the study of mathematics and astronomy, and obtaining such instruments as his means permitted he studied the heavens, and took advantage of every fine night to improve his knowledge of astronomy.

Knowing that a considerable amount of excellent work had been done on the Solar System and among the stars of the Northern hemisphere by Cassini, Flamsteed, and Hevelius, Halley thought it better not to enter into competition with these great observers, and decided to turn his attention to the Southern stars of which no good observations had then been made. It was reported that a Dutch observer named Houtman had observed these stars in the island of Sumatra, and that Blaeu, the globe maker, had used these observations in the correction of his celestial globes. But Halley, on examining these corrections, came to an unfavourable opinion about the observer and his instruments. Having consulted with some of his friends on the best station to choose for his proposed observations of the Southern stars, Halley decided on St. Helena. His father, a citizen of London, promised to supply him with the money necessary for the purpose. He was recommended to King Charles II. by Williamson and Jones Moore, and the Indian Company, who had control of the island, promised him all the assistance he required.

Having decided on the undertaking, Halley had a sextant of $5\frac{1}{2}$ feet constructed, somewhat similar to that of Flamsteed, and he procured telescopes and micrometers. The largest of the telescopes was 24 feet in length. He sailed for St. Helena in November, 1676, at the early age of 20, and after a satisfactory voyage of three months he arrived at the island.

Although he had heard good accounts of the climate, it proved very disappointing. Frequent rains and a constantly hazy sky hardly permitted any observations in the months of August and September, and although he lost no opportunity for observation he found that at the end of the first year he had only observed some 360 stars.

Notwithstanding these difficulties he consoled himself with the idea that his labours would not be wholly in vain, and he connected the stars he observed with others whose positions had been determined by Tycho Brahé. His catalogue of southern stars, reduced to the epoch of 1677, was published in London in 1679.

In forming his catalogue he had necessarily to identify the stars he observed, and in this connection he made the following remarks with reference to stars in the constellation Sagittarius: "It may appear strange that the stars which are before the left hock and the knees (in the ancient figure of a centaur), which Ptolemy called bright and of the second magnitude, are at present of the fourth at most. This appears to show if not corruptibility, at least the changeability of the celestial bodies. This diminution of light may be attributed to some accident. It is probable that for a similar reason the stars of the left leg and right knee are now so small that Tycho overlooked them." Halley further remarks that some stars which Ptolemy placed before (that is, west of) Piscis Australis, and of which four are noted of the third magnitude, are at present only of the fifth or sixth, and he asks if this is due to the diminution of their light in the lapse of time.

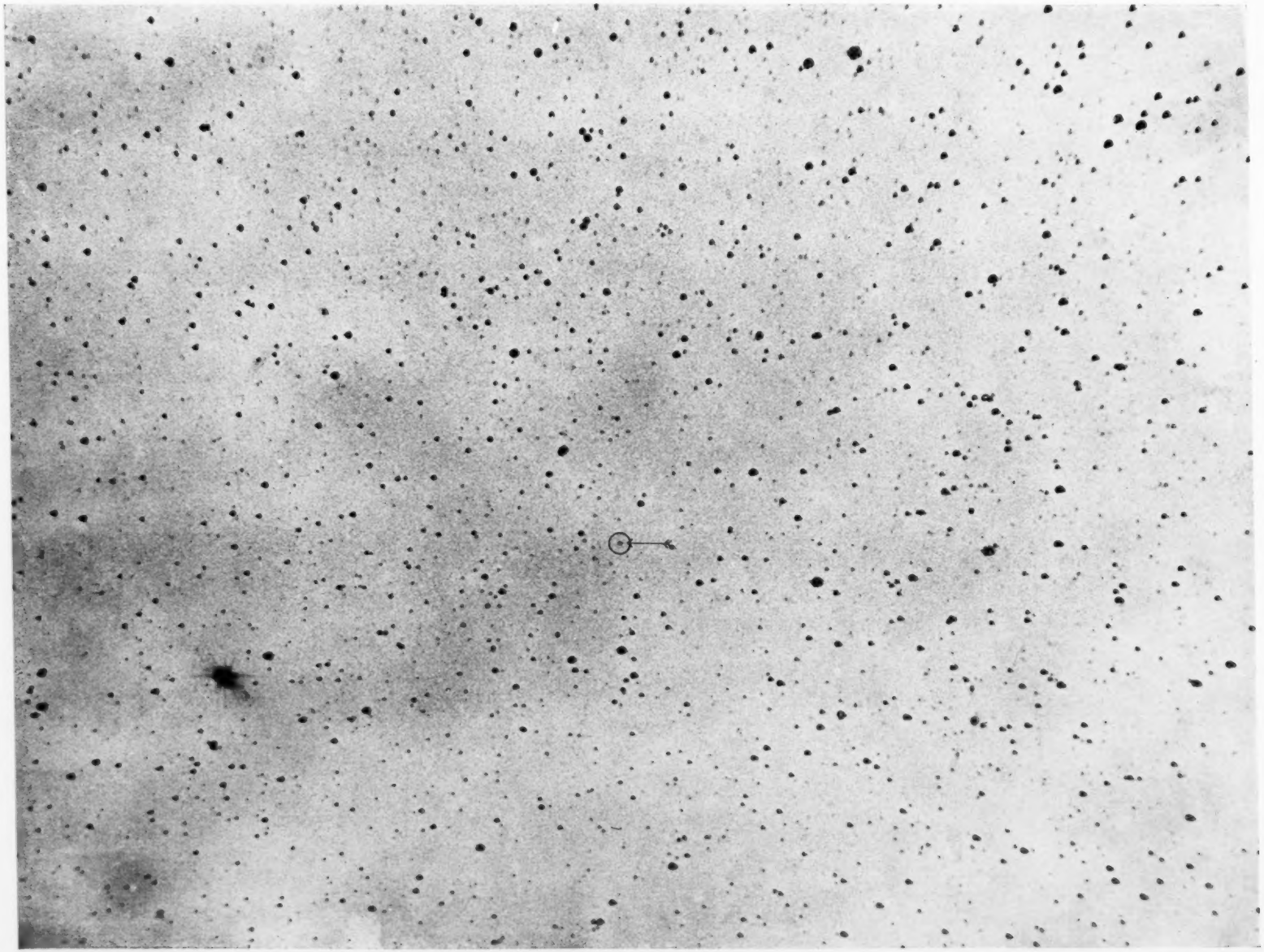
In addition to his work on the stars, Halley made some investigations on the moon's parallax, combining his observations at St. Helena with those made in Europe. He also made some researches on the theory of the moon's motion, which was not thoroughly understood in his time, and which were so necessary for the determination of longitudes.

On November 7, 1677, Halley observed a transit of Mercury across the disc of the sun. From his observations, which were not, however, obtained under favourable conditions, he derived a value of the sun's parallax of 45″, which is, of course, much too large, the real value being about 8″.8. But transits of Mercury are not suitable for measures of solar parallax, and, indeed, Halley pointed out that transits of Venus are much better for the purpose.

In 1679, Halley paid a visit to Hevelius to satisfy himself as to the accuracy of observation which the latter had claimed for his method of pinnules without the aid of a telescope. Halley convinced himself that the error of the observations made by Hevelius were less than had been supposed, and did not exceed a minute of arc.

In the year 1684 Halley paid a visit to his friend, Sir Isaac Newton, to confer with him about the law of gravitation which had been previously discovered by Newton. The result of the consultation between these great men led to the publication of Newton's famous work, the *Principia*. The first book of this immortal work was presented to the Royal Society of London in April, 1686, and ordered for publication in May of that year. But as the finances of the Society would not admit of paying for the printing of the work the expense was generously defrayed by Halley. The *Principia* was published in 1687, and it is pleasant to know that Halley's expenses connected with its publication were afterwards refunded by the sale of copies of the work.

Halley wrote a work on comets. Among former writers on the subject he found that the first account of a comet of any use for his purpose was one by Nicephorus Gregoras, who in the year 1337 recorded carefully the apparent path of a comet in the sky. But he was not so accurate in his record of *time*, and it was only on account of its having dated back by over 300 years that Halley included it in his catalogue of comets. The great comet of 1472, which made a near approach to the earth, was observed by Regiomontanus. This comet described an arc of 40° in one day, and is the first of which satisfactory observations were made. The comet of 1577 was well observed by Tycho Brahé. Kepler observed two comets, and from their parallax he concluded that comets pass freely through the planetary orbits along a path which differs but little from a straight line. These views were supported by Hevelius, but Borelli seems to have thought that comets moved in elliptical or parabolic orbits round the sun, and this theory was confirmed by the great comet



By permission of the Astronomer Royal.

The star plate taken at the Royal Observatory, Greenwich, on which Halley's Comet was first perceptible.

(The point designated by a circle and an arrow is the comet.)

of 1680, which the observations of Halley and Newton showed to be moving in a curved path round the sun.

In his researches on the motions of comets, of which he computed the orbits of 24, Halley noticed that those recorded by Appian in 1531, by Kepler in 1607, and by Halley himself in 1682, seemed to return after a period of 75 or 76 years. He thus suspected that these comets were one and the same. This suspicion seemed to be confirmed by the recorded appearance of bright comets in the years 1456, 1380, and 1305, the intervals again being 75 or 76 years. He rightly conjectured that the comparatively small differences in the recorded intervals were due to the disturbing action of the larger planets. This was especially so when he found that in the year 1681 the comet passed near the planet Jupiter, the attraction of which must have had a considerable influence on the comet's motion. Making due allowance for this disturbing influence of Jupiter, he computed that the comet would return to the sun's vicinity about the end of 1758 or beginning of 1759. Halley did not live to see his prediction fulfilled (he died in 1742), but the comet returned, and, according to the calculations of Clairaut, its nearest approach to the sun was due on April 13, 1759, with a possible error of one month. The comet actually passed through perihelion on March 13, 1759, only one month earlier than the date fixed by Clairaut! This showed the accuracy of Halley's foresight, and the comet has ever since been known by his name, although he was not its original discoverer. The comet again duly returned in 1835, and its next passage through perihelion will take place about April 20, 1910. This is now certain, as the comet was found on a photographic plate taken by Dr. Max Wolf on the morning of September 12 of the present year, within a few minutes of arc of the position predicted by the calculations of Messrs. Cowell and Crommelin of the Greenwich Observatory—a great triumph for astronomy and mathematics.

In addition to his merits as an astronomer, Halley was a good navigator. In 1698 he obtained command of a vessel and voyaged in the Atlantic Ocean for the purpose of making observations on the laws which govern magnetic variation. He returned to England in June, 1699. His lieutenant, who had given him much trouble, was dismissed, and Halley continued his voyage. He reached 52° of southern latitude, when the ice compelled him to turn back, and after some adventures he reached London on September 7, 1700. He had another voyage in 1701 and 1702, and then retired from travelling.

In November, 1703, Halley succeeded Wallis as Savilian Professor of Geometry at Oxford. In 1713 he was elected Secretary of the Royal Society, and in 1721 he succeeded Flamsteed as Astronomer Royal at Greenwich. He was then 64 years of age, but still full of zeal and energy. When Halley took charge of the Greenwich Observatory he found it almost devoid of instruments, Flamsteed's executors having removed all those which belonged to him. He obtained a meridian circle, similar to that of Roemer, which he used for four years to observe difference of right ascension. In 1725 a quadrant of 5 feet radius was set up in the meridian, and his efforts were chiefly directed towards the improvement of the lunar tables for the determination of the longitude at sea.

Halley observed the great aurora, which occurred on March 16, 1715, and his accurate prediction of the total eclipse of the sun on May 2, 1715, added much to his reputation.

He died on January 14, 1742, at the good old age of 85.

The Formation and Photo-Micrography of Crystals.

By J. H. CRABTREE, F.R.P.S.

To students of physical and chemical science there is much that is fascinating about the formation of crystals. This sphere cannot be said to have suffered from overstudy; indeed, much remains to be done in the way of original research to determine what conditions are most favourable to the crystallization of different compounds, and what definite forms of crystals are obtainable.

The magnificent agglomeration of crystals we may have seen in a snowflake just as it has fallen on the stage of a microscope affords some clue to the beautiful figures which are possible from this natural phenomenon.

We have ample opportunity of observing the formation of crystals in the common re-agents of an ordinary photographic laboratory such, for example, as hyposulphite of soda, sulphite of soda, hydrokinone, metol, citric acid, oxalic acid, acetate of soda, sulphate of copper, bichromate of potassium, bromide of potassium, and ammonium chloride.

We may also adopt a few materials from the kitchen, such as common salt, bicarbonate of soda, borax, alum, and Epsom salts. Experiments on these substances will yield most interesting results, with variations which should be carefully drawn and noted.

If greater variety be desired crystalline forms of exceptional brilliancy are accessible from salicine, santonine, quinidine, and amygdalin.

The formation of crystals requires care in the manipulation of the solutions concerned if success is to ensue. It is advisable to make "formations" with the microscope and camera in view, and for this purpose pieces of clear glass, such as cleaned quarter-plates, will answer admirably. Several of these plates should be treated with hot water and soda, stripped of all film, then rinsed in cold water and dried. By means of a glass-cutter we now divide each plate into four parts of about one inch wide. If we prepare a collection of 20 of these plates $3\frac{1}{4} \times 1$ inch there will be ample opportunity for experimental work with all the compounds named.

A test-tube stand, replete with tubes, should be in readiness along with a fair-sized Bunsen burner. Supersaturated solutions are conveniently made by dissolving each salt in boiling water over the Bunsen. A test-tube filled to half its length will be *quant. suff.*

The next stage is to secure the deposition of crystals under most favourable conditions. The glass slips already mentioned are arranged on a cold board, glass, or stone, which should be slightly—3 or 4 degrees—inclined to the horizontal. This holder is placed over a receiving tray to allow the dropping of surplus solution. Almost immediately the crystals of greater magnitude begin to form, and, as the cooling proceeds, smaller crystals will be manifest in lines, clusters, or separate individuals.

As even the largest crystals are, to ordinary vision, not very striking, a direct photograph scarcely does justice to the beautiful tracery dimly seen on the glass. A general view of the lines formed is best secured by pouring the hot solution on a whole quarter-plate glass and allowing this to become quite cold. The glass, with its superposed crystals, is then transferred to the printing-frame with, of course, the crystals outermost. The bare-glass surface is carefully cleaned with a damp cloth, then dried, and a piece of gaslight printing-paper

XUM

Fig. 1.—Metabisulphite of Potassium.

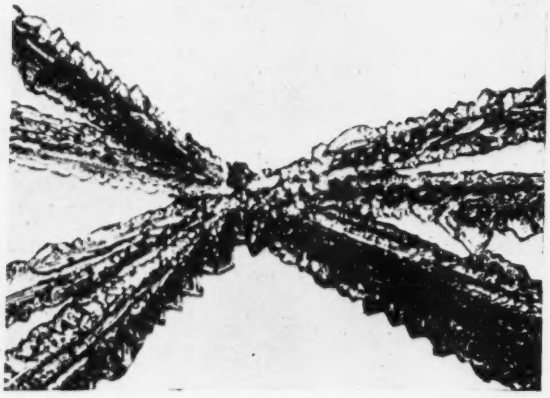


Fig. 2.—Sulphate of Iron.

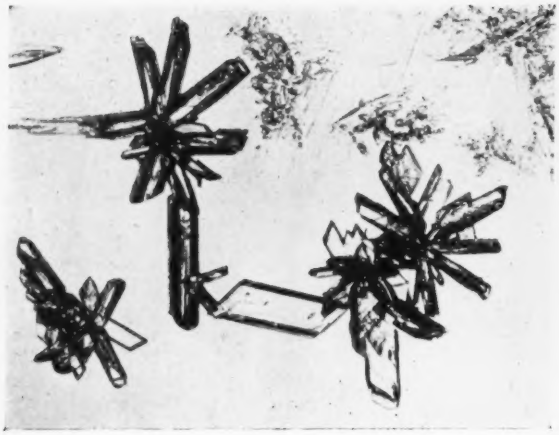


Fig 3.—Sulphate of Copper.

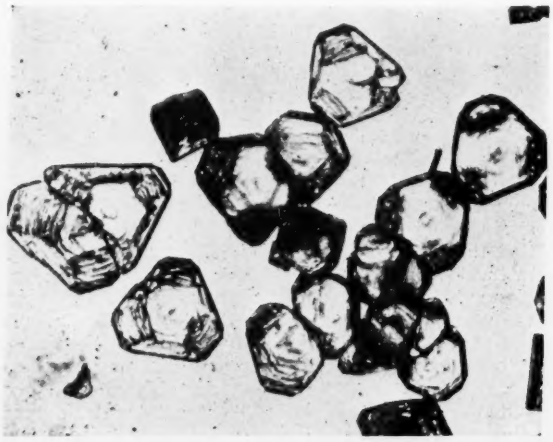


Fig 4.—Alum.

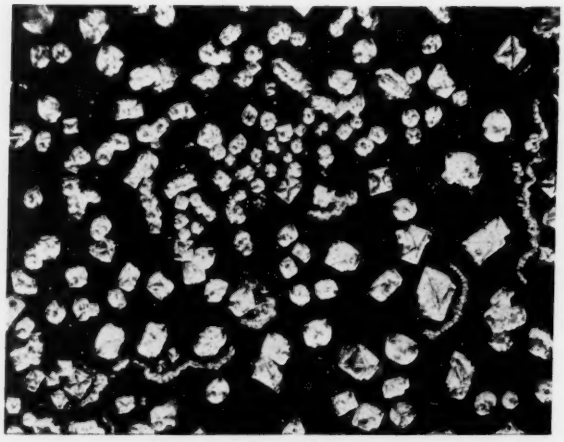


Fig. 5.—Common Salt.

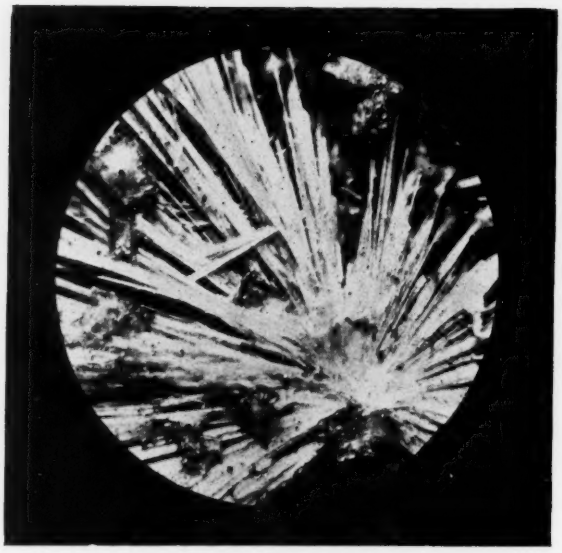


Fig. 6.—Bromide of Potassium.

is laid upon it. Printing is performed by a bat's-wing burner, allowing about 10 seconds exposure at 12 inches distant. The paper is developed in the following mixture:—Metol, 10 grains; quinol, 30 grains; sodium sulphite, 350 grains; sodium carbonate, 350 grains; bromide of potassium, 5 grains; water, 10 ozs. Of this mixture one ounce is added to 3 ozs. of distilled

Fig. 7.—Hyposulphite of Soda.

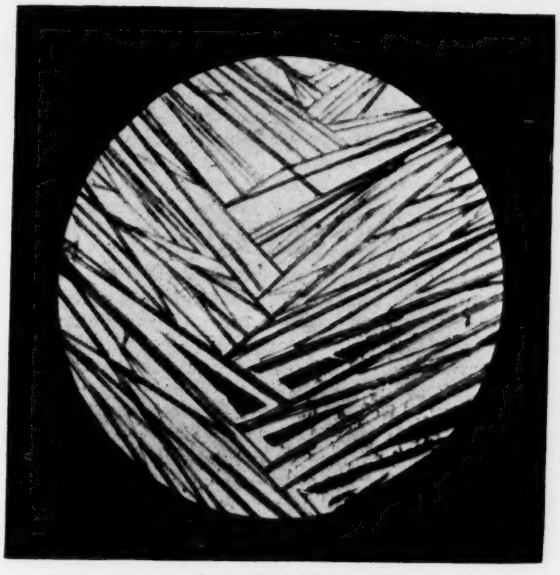


Fig. 8.—Hydrokinone.

water. The developer will avail for at least a dozen prints in succession.

To see the crystals more vividly, and determine accurately their construction, we must have recourse to the microscope. With objectives of 1, 1½, and 2 inches respectively it is quite possible to trace the finest examples deposited on the slips. What a revelation we find on the microscope stage—hidden almost entirely from unaided vision!

By adapting the camera to the microscope authentic photo-micrographs are obtained which are of valuable service both as records and for teaching purposes. Polariser and analyser are not absolute essentials when dealing with crystals. We may, by proper adjustment of the apparatus, obtain excellent examples on backed, orthochromatic plates with suitable light-filters. The camera is mounted on a box, say 3 inches above the working-table; this is made to move between slides, forward or backward, at the will of the operator. The camera lens is removed and the tube of the microscope, wrapped with an annular pad of velvet, is inserted in

Fig. 9.—Sulphite of Soda.

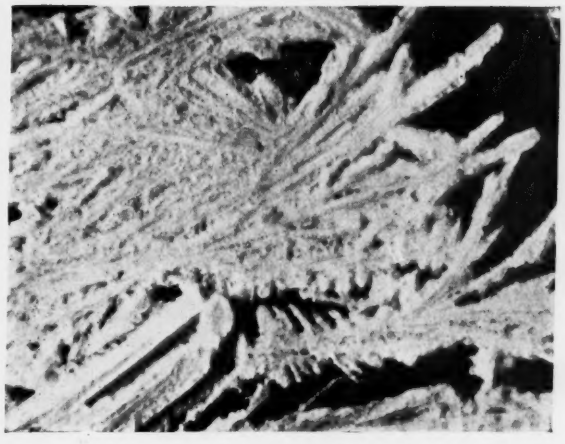


Fig. 10.—Sulphite of Soda.

the aperture. The velvet pad is then drawn close to the aperture and all extraneous light excluded. The tube is tested by means of a spirit-level to secure its being perfectly horizontal. The glass-slip with crystals, when on the stage, should be absolutely parallel to the photographic plate in the camera. The slip is made adherent to the stage with a small patch of photographic "stick-fast"; this is more convenient than either gum or sealing-wax. Objectives of 1, 2, or 4 inches will be found most suitable; the 1-inch records individual crystals with precision, the lower powers embrace clusters and lines of crystals.

Two methods of illumination are necessary—*transmitted* for transparent crystals, and *reflected* for opaque

or semi-opaque forms. Personally, I have a preference for the incandescent gas-mantle as an illuminant. It gives a brilliant white light of highly penetrative power, and thus allows of some adjustment of the iris-aperture in the objective lens of the microscope so as to bring all parts of the view—corners as well as centre—into perfect focus.

This illuminant, affixed to an ordinary limelight tray, is enclosed in a blackened chimney, slotted in front to allow a shaft of light to pass direct from the flame to the condenser, through the stage aperture, and so to the slide. Save for the top opening, which is partially covered, all other light is retained in the chimney. Light-filters are interposed, when dealing with coloured crystals, between the illuminant and the condenser. These are yellow, orange, pink, green, blue, or violet, according to the prevailing tint of the crystals. The essential point to be guarded is that the whole of the apparatus should be axial—light, condenser, slide, objective, eye-piece, and photographic plate.

When crystals are more or less opaque the light is reflected from one side of the stage. The illuminant and its chimney are portable and should be fixed at such an angle to the stage as to throw the crystals into bold relief. In this case no light whatever from the chimney should enter the objective lens unless reflected by the crystals. Filters are used exactly as with transmitted light, and the treatment of the photographic plate is similar.

The exposure of the plate depends on several factors, such, for instance, as the speed of plate, or the density of the light-filter. Using Imperial Special Rapid Ortho. plates I find 20 seconds sufficient for transparent crystals without filter, and 3 to 5 minutes for opaque specimens. A light yellow filter doubles or trebles the exposure, and a dense orange will increase it by 4 to 10 times.

NOTE.—Figs. 1, 2, 3, 4, 7, 8 and 9 are photo-micrographed by *transmitted* light; Figs. 5, 6 and 10 are by *reflected* light.

IN the course of becoming an exact science, medicine is paying greater attention than formerly to the action of drugs. While the general public, owing to the multiplication of pills and tabloids, is in most civilised countries acquiring the practice of drugging itself, the tendency among physicians is to limit both the number and quantities of drugs in use. Apart from these tendencies the most important aspect of the question is the repression of the adulteration of drugs. In some countries adulteration has grown to dangerous proportions, and the Second International Congress for the Repression of Adulteration in Food and Drugs, which is to be held in Paris this month, under the presidency of Dr. Bordas, is an event of considerable interest. At the recent meeting at Lille of the French Association of Science, M. Dorveau traced the history of what is perhaps the oldest known adulteration of food—the adulteration of coffee with chicory. The name of the gifted inventor of this mixture is unknown, but after a long discussion the date of the invention has been fixed as 1690—when the Dutch practised it. It does not seem likely that William III. brought it to England; but Prussia adopted chicory in 1763, and the French who did not use it till 1771, have since then been more active than any other people in spreading the adulteration. In the *Presse medicale*, whence this information is derived, appears an instance of adulteration of a very novel kind. It appears that what are known as "blood oranges" are sometimes converted to their sanguine hue by an injection of aniline dye. The fraud in a specific instance was detected by the discovery of a fine needle which had been used in the syringe. The needle was unfortunately discovered not in the orange but in the pharynx of a woman who had eaten one of the oranges.

Polar Geology.

WHOEVER may prove to be the first man to have set foot on the spot known as the North Pole, it is evident that there are no rocks there to delight the heart of the geologist. Nor have we at present any clue to the depth of the sea at the North Pole, and, therefore, to the actual extent of the flattening of the Pole so far as the solid crust of the earth is here concerned. Fossil remains in the Arctic Circle show clearly that polar regions were not always icebound, and, whatever astronomers may say, there must have been a time when the North Pole was removed considerably from its present position as regards the ecliptic. As it is now, it is interesting to note that the ocean which stretches across and around the Pole is itself surrounded by a belt of land which encloses it, namely, the northern coasts of the great continents. Is there any geological significance in this? We cannot imagine the Arctic Sea to have always been oceanic any more than we can imagine Central Asia always to have been dry land. The rise of the latter may have contributed towards the bringing about of the former. When Britain was overwhelmed by glaciers and then by an ice-sheet, she yielded beneath the weight and for the most part disappeared beneath the sea. When the north polar regions ceased to bear sub-tropical plants and became overwhelmed with ice, similar results may have followed. The North Pole is now, in fact, in a similar condition to that of Britain and Scandinavia at the close of the greatest period of glaciation in our Ice Age. Then Britain rose again from beneath the icy waves and shook off her covering of ice and snow, with an amelioration of her climate, and the North Polar regions may yet do the same. It is well to remember, however, that should land again arise at the Pole, it will probably be at the expense of a wide tract of land elsewhere, which would suffer subsidence, independently of the rise of the displaced waters from the Pole. There is land at the South Pole, probably, but it is isolated by a ring of oceans. The existence of the one may be the cause of the other, and the present arrangement of land and water in the North Polar regions may be reversed in ages to come, and agree with the conditions now obtaining at the South Pole. In such circumstances Eastern Britain and Northern Germany would be overwhelmed, whilst Central Asia would become like an eastern Mediterranean once again. It may be said that these remarks are speculative, and I do not deny it, but so much depends on the question as to the fixity or otherwise of the axis of the earth, independently, I mean, of such changes brought about by precession and nutation. I should like to draw our friend who conducts the astronomical column on this question. Then, again, what is the cause of a magnetic pole, and is it possible that at one time the two Poles were identical for a long period of time? I should like to hear our physical editor on this point. Glacial geology would like to know what, in the light of modern learning, her sister sciences have to say on these, to her, important topics.

E. A. M.

WE are glad to hear that Mr. J. H. Elgie's book on "The Night Skies of a Year" will soon be ready for publication by Messrs. Chorley and Pickersgill, of Leeds. We welcome all such aids to the study of the starry heavens, and we have reason to believe that Mr. Elgie's forthcoming book will be one of deep interest, and also of great usefulness.

A Popular Observatory.

By ARTHUR MEE.

A WELCOME witness to the steadily increasing volume of popular interest in astronomy is found in the number of public observatories in various parts of our islands. Of these the one at Edinburgh is the oldest and the best known example, and there are others at Leeds, Paisley, and elsewhere, all doing excellent work. One of the most recent is that at Cardiff, which is worthy of note for two reasons, in the first place because it is the only one of the kind in the Principality of Wales, and in the second place because its rapidly acquired success has been achieved in an eminently hard-headed business centre where people invariably view things from the standpoint of bread-and-cheese and of the almighty dollar. When, fifteen years ago, the writer set about founding the Astronomical Society of Wales, he was told by Cardiff friends it would never come to fruition; and when, some years later, it was sought to establish a public observatory in the Welsh metropolis, the advocates of the project were dubbed "cranks" and only with the greatest difficulty were the municipal authorities won over to entertain the project and to give it their support.

The idea of a public telescope for Cardiff was first broached in the columns of a local daily paper, the *Western Mail*. Correspondence followed which caught the attention of a well-known local scientist, Mr. Franklen Evans. Mr. Evans had for long been an active member of the Cardiff Naturalists' Society, and kept a careful meteorological record for forty years prior to his decease. He also took much interest in astronomy, and had acquired a fine 12-inch equatorial reflector by Calver, which, with a sidereal clock and other accessories, was housed in an observatory in his grounds. This telescope had previously been the property of the Rev. (now Canon) Conybeare Bruce, who was an enthusiastic observer, and whose increasing clerical duties made him regretfully relinquish work as a practical astronomer. Whilst the telescope was in his care it was tested and used by experts like the late Mr. Herbert Sadler and the late Mr. T. W. Webb, who were enthusiastic in praise of its performance.

Mr. Franklen Evans, finding his sight failing, generously offered his reflector and its appointments for the use of the public of Cardiff on the sole and very reasonable condition that his gift was adequately taken up by the local educational and scientific bodies. Upon this offer being made public the matter was pushed forward by the Naturalists' Society and the Astronomical Society of Wales. The problem of a suitable site and of securing an attendant, however, presented difficulties, and it was a long time before any progress was made. The Corporation was approached, and viewed the matter with amused indifference, till Councillor J. A. Kidd took it on himself to "convert" his colleagues. He threw himself heart and soul into the difficult task, and with such success that, from being opponents, the city fathers became in the main warm supporters of the project.

In the result a site for a city observatory was selected at Penylan Hill, 200 feet above the sea and a short distance to the north-east of Cardiff, well above the range of its smoke, and possessing a clear horizon. A neat but very substantial building was put up under the superintendence of the city engineer. The telescope was thoroughly overhauled by its maker, Mr. Calver, and fitted with a driving clock. In the final arrangements much assistance was rendered by Mr. Albert Taylor, F.R.A.S. The observatory was formally opened by the Lord Mayor in 1906, and the details are duly inscribed on a brass plate within the building. A visitors' book is also kept, and is being rapidly filled by the large and increasing number of visitors hailing from all parts. The telescope is available to the public free every week night from September to May. It is in charge of an intelligent Corporation attendant who has made himself thoroughly familiar with its working as well as with the position and nature of the more "popular" celestial objects.

This, however, is not all, for the Corporation has installed on the ground adjoining the observatory a complete set of meteorological instruments, to which the Cardiff Naturalists have just added a seismograph, the latter being the only one in Wales. For the stirring up of the enthusiasm that led to the acquisition of this instrument the public are largely indebted to the exertions of Principal E. H. Griffiths, F.R.S. The seismograph has, of course, a special building of its own. It is of the pattern known as Milne's horizontal pendulum, with special recording attachment. The sensitive recording sheet is changed and developed daily and the records circulated. The meteorological instruments are also read daily and particulars posted up in the city and published in the Press. It will thus be seen that the observatory at Penylan, Cardiff—controlled by a Committee of Councillors and local scientists—has already become a focus of scientific and intellectual activity, and still greater things are expected of it in the future. The curious may like to note that it stands exactly in the latitude of Greenwich and the longitude of Edinburgh, and thus links in a scientific chain the capitals of England, Scotland, and Wales.

Cardiff, by the way, though pre-eminently a business centre, is not without its astronomical associations. Admiral Smyth, author of the "Celestial Cycle," once held a post there in connection with the Docks, and lived for some time in what is now the metropolis of Wales. A bust of him is in the Museum. The Rev. John Webb, father of the author of "Celestial Objects for Common Telescopes," was vicar of Cardiff for a number of years. An astronomical exhibition at the Museum in 1908 was visited by thousands of people from all parts, and a permanent exhibit is on view at the Public Library. The work of the Astronomical Society of Wales, which meets at the new University College and numbers about 300 members, is also becoming recognised. It is the third largest astronomical society in the kingdom, and actually the largest in the provinces—not a bad record in 15 years.

SOMETIMES a vague rumour is heard that an engineer has found some way of utilising the enormous waste power of sea waves for mechanical purposes. No invention has yet, however, proved of any practical value. A paper read by Signor Riccardo Salvadori before the Italian Electrotechnical Association furnishes some good reasons why this gratuitous form of energy cannot be utilised. One of the difficulties is the extreme variability of the supply of energy; but even if this difficulty were overcome and the energy were accumulated (in reservoirs of compressed air, for example) the cost of the apparatus of accumulation would be prohibitive. The principal reason, however, why wave-power cannot be profitably captured is that the mean horse-power of waves is really quite small. On most coasts waves a yard high would furnish only one horse-power per yard of coast. Waves two yards high would give seven horse-power per yard of coast, but the number of days in a year when these waves occur is comparatively small. The three-feet wave is that which occurs on more than half the days of the year, and the cost of an installation which would conserve its energies would work out to £200 per horse-power—a prohibitive cost.

XUM

The Bristol Museum Extension.

The New Greville Smyth Room.

By H. VICARS WEBB.

AN important extension of the Bristol Museum has recently been effected, substantially adding to its attractiveness and increasing the scope of its usefulness. A few years ago the Museum was enriched by the Greville Smyth collection of insects, birds' eggs, nests, and skins—an extremely valuable collection—presented by Lady Smyth; and more recently the Corporation received an offer from her to defray the cost of fitting up a room to be specially identified with the exhibits associated with the name of her husband, the late Sir Greville Smyth.

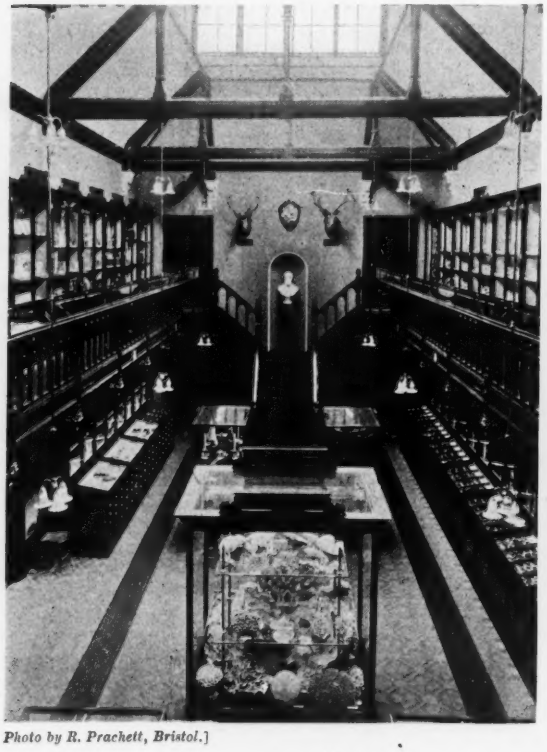


Photo by R. Prachett, Bristol.]

The old reference library has been utilised, the many thousands of books at one time stored there having found a home in the new Municipal Central Library. This part of the Museum building has been re-roofed, translucent green glass being put in to soften the light, and blinds provided to prevent direct sunlight striking the specimens now set out. The large room, 60 × 30 feet, has been transformed into an elegant and inviting department of the Museum, into which all the invertebrate collections are brought, the great feature being the Greville Smyth exhibit of insects.

While the Chairman (Alderman Barker) and members of the Committee have zealously furthered the work which has been undertaken, special acknowledgment has to be made of the valuable services of Mr. H. Bolton, the Curator, who has supervised the whole of the exhibits and had them set out to the best advantage. In the preliminary classification of the Greville Smyth collection Mr. Bolton received assistance from Messrs. Griffiths and Charbonnier, two local naturalists. The whole of the fittings of the room on the ground floor and gallery are of the finest Honduras mahogany, and these consist of upright and sloping air-tight cases glazed with plate-glass, the interiors being arranged with adjustable standards, brackets, and shelving on a plan suggested by Mr. Bolton. Beneath the cases are arranged stacks of insect and store drawers. An alcove on the landing leading to the gallery forms a fitting position for a marble bust of the late Sir Greville Smyth, above which are displayed the Smyth arms flanked by two fine heads of deer from Ashton Park. A handsome central case for the display of corals occupies a prominent position on the ground floor, together with other cases showing flexible corals, sponges, and mollusca.

Some idea of the extent and value of the Greville

Photo by R. Prachett, Bristol.]

Smyth collection of exhibits may be gained from the following census made by the Curator at the time of the generous gift :—

Birds' eggs in clutches	2,099
Birds' eggs not in clutches ..	10,000
Nests with eggs	600
Bird skins	1,700
Insects	13,813
Mollusca and varia	604
Grand total	28,810

Unfortunately, there is no room at present available for the display of the large collection of bird nests, eggs, and skins. These are all stored away in cabinets and drawers. The extensive collection of butterflies is arranged in 22 stacks of drawers extending the whole of one side of the room, the desk cases being occupied by a selected series of the most interesting forms, mounted by an entirely new method, and in most cases

XUM

Reproduced by kind permission of the Directors of the Paris Observatory.

The Moon.

upon finely modelled examples of food plants. An upright cabinet behind the desk cases contains an index series of insects. This series, which has occupied many months of close work, is of a somewhat remarkable character. Types have been taken of all the great groups of insects and their several parts carefully dissected and named. In many cases full life-history groups are shown, and the insect can be followed in all its stages from the egg to mature life. Around the balcony the exhibits include a comprehensive series of shells, with tablets, all arranged on methodically instructive lines, a dictionary of terms illustrated by actual specimens, and shells of the Bristol district are, of course, in the section. An exceptionally fine collection of corals is also amongst the exhibits in a department of special interest.

The Greville Smyth Room, which was appropriately opened by Lady Smyth herself, should have the effect, especially among the younger citizens of Bristol, of stimulating the study of natural history, any branch of which breathes the gospel of the open air.

Photograph of the Moon.

THE accompanying Plate represents a portion of the S.E. quadrant, which contains many interesting features, some of the most important are worth a few remarks.

Bullialdus.—A grand crater or ring-plain 38 miles across and 9,000 feet deep. It contains a central hill 3,200 feet high. The walls are much terraced and there are some long valleys and several rows of crater-like depressions on them.

Mare Nubium.—Is bordered by considerable mountain regions and there are many isolated mountains and ring-plains, also ridges on the surface. In many places it is crossed by long light streaks.

Straight Wall.—A most remarkable formation, more than 60 miles long, and 1,000 feet high. It begins at a small crater and ends at a branching mountain. It may be well seen from 1 to 2 days after 1st quarter.

Thebit.—A ring-plain 32 miles broad, with very steep wall which rises in one place to a height of 9,835 feet above the interior. In the centre are several elevations, and on the N.E. the walls are broken by a deep crater.

Pitatus.—An extensive walled plain. The S.W. portion is tolerably steep and contains a crater close to two peaks and ends at a small ring-plain close to three small craterlets.

Wurzelbauer.—A nearly circular walled plain bordered on the west by the high plateau between Gauricus, Pitatus, and Wurzelbauer. The interior is one mass of irregularities consisting of long ridges enclosing deep valleys.

Gauricus—An irregular walled-plain containing a few hills and a crater pit or two. Two peaks on the west border rise 4,783 feet above the interior.

Hell.—A ring plain 18 miles in diameter. It is situated in a comparatively level region and has broad, steep, terraced walls, rising on the N.W. about 9,000 feet.

Lexell.—A regular walled-plain with walls of very unequal height, 7,712 feet in one place, and pierced by a fine narrow valley. The interior contains a central peak and some ridges.

Walter.—A walled-plain more than 100 miles in diameter, surrounded by a wall composed of a number of separate peaks and mountain chains, divided by valleys and united by cross walls.

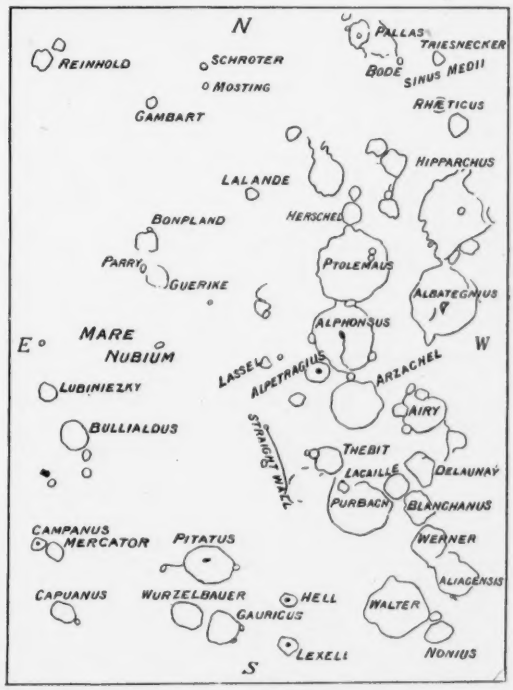
Werner.—A ring-plain 45 miles in diameter, with a lofty wall rising on the E. 16,543 feet. The interior contains a peak 4,572 feet high.

Aliacensis.—A ring-plain 53 miles in diameter with broad, lofty terraced walls, towering in one place 11,964 feet, and in another 16,537 feet above the interior, which contains a central peak.

Purbach.—A ring-plain about 7,500 feet deep.

Blanchanus, *Delaunay*, and *La Caille.*—The first is a crater with a terraced ring and a peak; the second, an irregular ring-plain with a wall rising 11,600 feet above the interior; and the third, a small walled-plain crossed by many valleys.

Arzachel.—A ring-plain 65 miles across, with a wall rising to a peak of 13,600 feet, though only 6,043 feet above the outer surface.



Alphonsus.—A fine walled-plain 83 miles across with a much terraced wall rising at one place to 7,034 feet.

Albategnius.—A walled-plain 64 miles in diameter with a level interior containing a central mountain nearly ten miles long, and 4,157 feet high.

Ptolemaus.—The largest of this chain of walled-plains, with a diameter of over 114 miles and an area of 8,500 square miles. There are many craters on the floor, two of which are conspicuous.

Triesnecker.—A ring-plain 14 miles in diameter with a regular wall rising 5,424 feet high. W. of it is one of the most remarkable rill systems on the moon.

Hipparchus.—A great walled-plain extending for 96 miles from N. to S., and 87 miles from E. to W. Its borders are very irregular with many craters.

Rhæticus.—Is one of the few formations that can have both sun and earth in its zenith. The highest point in the wall is 5,000 feet, and there are many craterlets.

XUM

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The Royal Photographic Society's Exhibition.

This exhibition closed at the end of last month. The Executive of the Society has returned to the custom of inviting those whose pictorial work is selected to state the method of its production. As might be expected, a considerable number of these photographs were by processes that have been devised on account of the special facility that they offer for varying the result by other than photographic means. The Scientific and Technical section was notably larger and of greater interest than it has been for some few years. This section would be more useful if it were more strictly classified. The astronomical photographs, for example, might be all kept together whether they are transparencies, lantern slides, or paper prints, and they might be rigidly and markedly separated from the natural history photographs, the radiographs, etc. The principal items in colour photography were to be seen in the further development of the Thames plate, and in some exceedingly fine three-colour typographic work exhibited by Messrs. Wratten and Wainwright. In some cases the original and the print were shown side by side, which is the only satisfactory way of attempting to demonstrate the perfection of such work. From a technical point of view the exhibition was in advance of the last few exhibitions, and the few changes that the Society has made are in the right direction.

The Effects of Colour Screens.

Colour screens, or filters as they are often called, are now very largely employed for the sake of their colour, and too often attention is paid only to this matter. If the screen is used between the light and the object, as is often possible when artificial illumination is employed, or by daylight when the work is indoors and the windows of the studio are coloured, the colour is the only circumstance that calls for attention, providing that the evenness of the illumination is not interfered with by changes of thickness in a transparent screen. An incandescent electric lamp, for example, will not give even illumination because of the irregularities of the glass, unless the globe is roughened or "obscured." The ground-glass scatters the light, and for many purposes obviates this difficulty.

But if the screen is between the object and the image, as it is whenever it is attached to the lens or camera, it cannot be without action on the image-forming rays and consequent effect upon the image. If it is irregular in its substance or shape it is well known that it will distort the image, hence the careful selection of flat or optically worked glass. But granting that the glass has perfectly flat and parallel sides, its effect upon the image is definite and may be important. If regarded as acting on the image as a whole, it will produce a displacement of the parts of the image that increases as the obliquity of the rays to the glass screen increases, and this will result in curvilinear distortion. Those who use microscopes know that the "cover-glass" which comes between the object and the objective produces an effect equivalent to negative spherical aberration and that it is important to have the spherical aberration of the objective only partly corrected, or to have the correction adjustable, to allow for this. For the same reason sub-stage condensers are undercorrected, the glass slip in this case coming between the condenser and the object. It must not be supposed that the spherical correction of photographic lenses is interfered with to the same extent by the use of colour screens, because the obliquity of the light incidence is not so great nor is any practical colour screen of a thickness even approaching that of the cover-glass or slip when compared with the distance between the lens and the object. But some colour screens, and cells of coloured liquid which are used, are very thick, sometimes approaching an inch, and wider angles are often included now that lenses with a much greater covering power are available. When increasing the aperture, the angle of view, or the thickness of the screen, these effects should be borne in mind, especially in critical work.

To Minimise the Aberrations caused by Colour Screens.

As these and other aberrations are caused by the thickness of the screen and the oblique passage of the light through it, it is desirable to use thin screens (granting, of course, equal optical perfection) and to place them where the obliquity of the light will be at its minimum. This position will be between the lens and the more distant conjugate focus, that is, generally, when the image is smaller than the object, outside the lens. For thinness of the screen the coloured films now so common are excellent, though some of these are liable to have ridges and swellings that markedly interfere with the definition, much more so than the thickest optically perfect screen that is ever likely to be proposed for use with a camera. Indeed, such irregularities are of far greater importance, from a practical point of view, than any aberration produced by an optically perfect screen.

This subject of the effects of colour screens has been lately dealt with at length by M. G. Sacco, and an account of his work will be found in the British Journal Colour Supplement for July. When working through from the back of the plate, which is necessary in screen plate colour photography, sometimes for reversed negatives and also for astronomical purposes, the glass plate comes between the lens and the image, and, therefore, produces similar effects to those referred to above. It is of interest to note that Mr. Schlesinger, of the Harvard College Observatory, finds that the distortion is so slight that star photographs made with a reversed plate can be used for charting purposes. Here, of course, the obliquity of the light is comparatively small.

Received.

"The Photographers' Note Book on Lenses" is a small volume by Mr. Conrad Beck, published by Messrs. Beck, of Cornhill, which the firm will send free to any applicant. Although given away, this little book has about eighty pages out of ninety-four devoted to the consideration of photographic lenses, their properties, adjustments, and types, with chapters on lenses for hand cameras and tele-photography. The subject is treated clearly and in a thoroughly practical manner, so that anyone who masters this "Note Book" will have a very good idea as to what his lenses can do and how to use them to the best advantage.

"Wratten Light Filters" is a pamphlet of thirty-six pages which contains a complete description of the seventy-seven colour screens that Messrs. Wratten and Wainwright, of Croydon, are prepared to supply. These include filters for orthochromatic work, tricolour photography, microscopy, mono-chromatic light, and other purposes. Diagrammatic spectra are given of these filters, of the well-known series of Wratten's plates, daylight spectra of orthochromatic and tricolour filters, and the mercury green line filter, which, used with a mercury vapour lamp, gives the most brilliant light that is really monochromatic.

XUM

The Common British Centipede, *Cryptops hortensis* Leach.

By W. WESCHE, F.R.M.S.

THE student who lives in London, and wishes to become familiar with the anatomy of the Chilopoda section of the Myriopoda, has not far to go to find material. In the soil of gardens, miles inside the buildings of the Metropolis, he will come across our common centipede, *Cryptops hortensis* Leach, and this arthropod will give a very fair idea of most of the structures that can be found in even exotic forms. The classification of genera is easy; simple eyes characterise *Scolopendra* and *Lithobius*, but *Lithobius* is distinguished by the body segments, being unequal in size; *Cryptops* is without eyes; and *Scutigera* has compound eyes. The genus *Scolopendrella* has become of much importance of late, but I have no practical knowledge of the anatomy. Gervais,* who discovered *S. notacantha* in 1847, gives a figure showing single eyes, nine pairs of legs, curious foliate plates on the dorsum, and a pair of cerci at the anal extremity. This last character would mark it off from the other Chilopoda. The separation of species is difficult, as immature forms are present, and during the stages of growth surprising changes of structure take place. The number of joints in the antennæ alter; in *Scolopendrella* Gervais figures changes in the morphology of this part† In *Cryptops* the armature on the last pair of legs seems to undergo changes, and even the number of these appendages varies, only seven pairs being found in immature forms of *Scutigera* and *Lithobius*.

But these complications are not likely to trouble the beginner, at all events in London, as if he turns over the earth in his garden and finds a centipede of a dark brown colour, which, though without eyes, appears to be sensitive to light, as it runs quickly and endeavours to hide itself under stones or soil, is about an inch long, with twenty-one pairs of legs, seventeen joints in the antennæ, and, as I said before, no eyes, he is most likely to have captured *Cryptops hortensis* in a mature, or close to a mature form.

The orthodox method would be to place the animal in a phial of spirit, label it, and endeavour to capture other species, till the British list was exhausted, or the crowning glory of an addition to the British list was arrived at, when all the phials would be placed in a cabinet, and the energies of the collector might be turned to some other form of slaughter, or to the equally enlightening amassment of postage stamps, or acquirement of old china or crockery. But as I hold with Lord Avebury's views on Natural History, and regard it as altogether different from stamp collecting, or any other form of collecting for the questionable pleasure of mere acquirement, I propose to try and learn something of the habits, and of the relationship to other forms of life, by a study of my specimens. To do this I take a whole *Cryptops* and prepare and mount it for the microscope. I study this slide, and then take another specimen and, dissecting such parts as I cannot understand or appear obscure in the first preparation, I mount them separately, trying various stains to bring out indistinct structures.

In case I am ignorant of the habits or life-history of my specimen, a study of the preparations will tell me several things. The absence of eyes shows that it is either one of the rare cave forms, or is parasitic, or is nocturnal or subterranean. The shape of the legs and claws show that it is not parasitic, and that leaves the nocturnal or subterranean habit as far more likely than the cave-dwelling habitat. The large lower jaws, which are not unlike the falces of spiders, suggest a predaceous habit, and the stomach confirms this, as I find numerous remains of insects in my preparations, but the presence of pollen and other vegetable matter shows that *Cryptops* is not exclusively insectivorous.

In one preparation the joints of a leg can be made out, which, from the character of the pubescence, I think is that of a small Tipulid; another specimen contains a number of small legs and the remains of some larger limbs, together with quite a number of small mites, which I conjecture to have been parasitic on the larger insect and were swallowed with it. Comparing my exotic specimens, I find these are even more fiercely predaceous, as I find the remains of a Lepidopteron and some small insects, probably Aphides, in a *Scutigera* from Kashmir; and of a great number of insects in a *Scolopendra*, also from Kashmir; this last is but an inch and a half in length, yet I can distinguish the remains of eighteen different insects with certainty, and probably four to six more are there entombed in the abdomen; I can recognise several wings of Diptera, several heads and legs of Hymenoptera, including the antenna of what was probably a Chalcid, part of the elytra of a Coleopteron, and twelve pairs of eyes of Nematocerous flies. The capture of such a large number of winged insects proves the nocturnal habit of the apterous arthropods.

We now come to the relationship to other forms of life. The most cursory examination shows that in *Cryptops* is a form intermediate between that of an insect and a many segmented worm; the chitin which covers the arthropod is identical with that on the insects; the antennæ are like those found on many insects, and would be impossible to separate by any test that I know of; that is to say, if they were cut off and mounted separately, the most experienced observer would be unable to say with certainty that they belonged to an arthropod and not to an insect; the tracheal system is alike in both Orders. Here the similarities end, as the mouth parts differ; there is no differentiated thorax, and each one of the numerous segments carries a pair of legs. These legs are the most striking feature of all centipedes, and are unlike the legs of insects; in *Cryptops* all except the two posterior pairs have only four joints and a single claw, while the legs of insects are made up of coxæ, femora, tibiæ, two to five tarsi, and a pair of claws, besides a horny plate between the claws, which bears various structures. (Figs. 1, 2, and 3.)

The two posterior pairs of legs in *Cryptops* have five joints, and are turned backwards; it will be seen that this differentiation is not without significance.

Though the limbs have so many points of difference, there is a part of the interior anatomy which is peculiar and at the same time exactly similar in both Orders; this is the tendon to which the claws are attached; this takes a stain very readily and can be traced through the joints and examined with high powers; it is then seen to be tubular and opens at the base of the claw, or behind a plate at the base of the claws of the insects.

* Histoire Naturelle des Insectes - Apteres Walckenaer et Gervais—plate 39, fig. 7.

† Ibid.

XUM

In these it appears to irrigate or moisten the pulvilli, as the plate mentioned above seems porous, or to consist of a number of layers, or scales placed one over the other. At all events, this tendon seems absolutely homologous and similar in structure; though it may not be possible to compare the joints, yet it shows clearly that both the arthropod and insect limbs are derived from the same ancestral form. (Figs. 1, 2, 3, and 4.)

Other genera of the Chilopoda have more joints in the legs than *Cryptops*. A species of *Scolopendra* has five joints (Fig. 3); a *Scutigera* has three long joints and a great number of tarsi (46 to 40), but these can be divided into five divisions on their natural appearance—(1) a long joint followed by (2) a varying number of short joints, (3) a moderately long followed by (4) a number of very short joints and then (5) a moderately long joint to which the single claw is attached. These seem to suggest the five tarsi of the insects, and through them all runs a tendon of the same type as in the others. I have made a large number of preparations of the legs of Chilopoda and Insecta to illustrate this point, and propose to give figures of a few.

That the legs are the dominating character in the centipedes is even more accentuated when the mouth parts are examined, as the great jaws which stand out on the sides of the head are very obviously only modified legs, consisting in *Cryptops* of four joints with the claw enlarged. That they are homologous is proved by the presence of the tendon; this appears at its base to spread out, as if to form a gland (Fig. 5a). If this was the only structure in the claw it would be an easy matter to identify it as the poison bag which is known to exist in the jaws of many Myriopoda, and whose venom is in some cases dangerous even to man; but in *Scutigera*, *Cryptops*, and *Lithobius* is a very beautiful and characteristic structure, which is possibly this poison gland. In *Cryptops* it consists of a chitinous bag which communicates with an opening on the outer side of the claw, the "tendon" appearing to open on the under-side of the same part. This bag is studded with a great number of short funnel-shaped openings, and has an appearance which suggests the function of a sense organ, and not that of a poison gland. There is not the least suggestion of such a structure in the poison sac of *Scorpion*, or in the falces of five species of Arachnidæ that were examined; they are smaller in size than the posterior expansion of the "tendon." (Figs. 5b and 6.)

The claws of the centipede are also poisonous, and I well recollect, when in India, seeing a forearm across which a centipede had run; it was marked as with the lash of a whip, and the minute punctures of the many claws caused much irritation to the victim. As the claws of the exotic species that I have examined are quite similar to *Cryptops*, I am inclined to think that the tubular tendon conveys this irritating fluid to the claws, and the expansion of the tendon into a sac in the jaws, suggests that this is possibly the true poison gland, and not the chitinous bag, though the opening of the latter at the tip of the claw is very obvious and difficult to get over. (Figs. 4 and 6.)

At all events, be it sense organ or poison gland, it is interesting that I have found in the maxillary palpi of a number of species in the Dipterous Nematocerous families Rhyphidæ, and Simulidæ, a sense organ which is unlike all other sense organs that I am acquainted with, and suggests by its structure, that of a tubercle or funnel studded sac, a similarity to this organ.

To return to the jaws, they are on the under-side of the head, and are articulated into a piece consisting of some rather complicated folds, which is the remains of a body segment or annulation, and suggests a homology with the maxillipeds of the Crustacea. (Fig. 5.)

When the jaws are removed, a pair of three-jointed palpi can be seen, also supported by a single plate; these are obviously, like the jaws, modified legs supported by a body segment, and have a minute claw still remaining, but are more altered than the poison jaws, having lost a joint and all trace of the tendon. (Fig. 7.)

Behind the palpi a labium-like structure appears, also consisting of three joints, and articulated on to a plate, but this plate is divided in the median line and also probably represents a segment. (Fig. 7.)

This covers a very beautiful and complicated pair of biting jaws, which are very similar in the Kashmir *Scutigera;* in each a stipes or lever supports three irregularly-shaped pieces, the distal having in *Scutigera* three, and in *Cryptops* four teeth, and below these about eight beautifully ciliated fans to sweep the food, cut by the teeth, down the pharynx. (Fig. 8.)

If we count these biting jaws as representing a segment it will be seen that five have been taken up in forming this head, the one which supports the antennæ making the fifth.

It can now be seen that as the mouth parts in *Cryptops* are very obviously only modified legs, the probability is great that the appendages in Insecta (excluding the wings) are also derived in a similar manner.

Many insects have elaborate claspers or egg-guides at the posterior extremity, and these are often four in number, consisting of two pairs; in some instances true joints are present as in the Dipterous genera *Gynoplistia*, *Culex*, and *Phlebotomus*. These would also be modified legs, and it is striking that the last two pairs in *Cryptops* have more joints than the others, and are like those in most Myriopoda directed backwards, differing thus in structure from the others, and suggesting that they are the homologues, or represent the former condition of the anal appendages of Insecta.

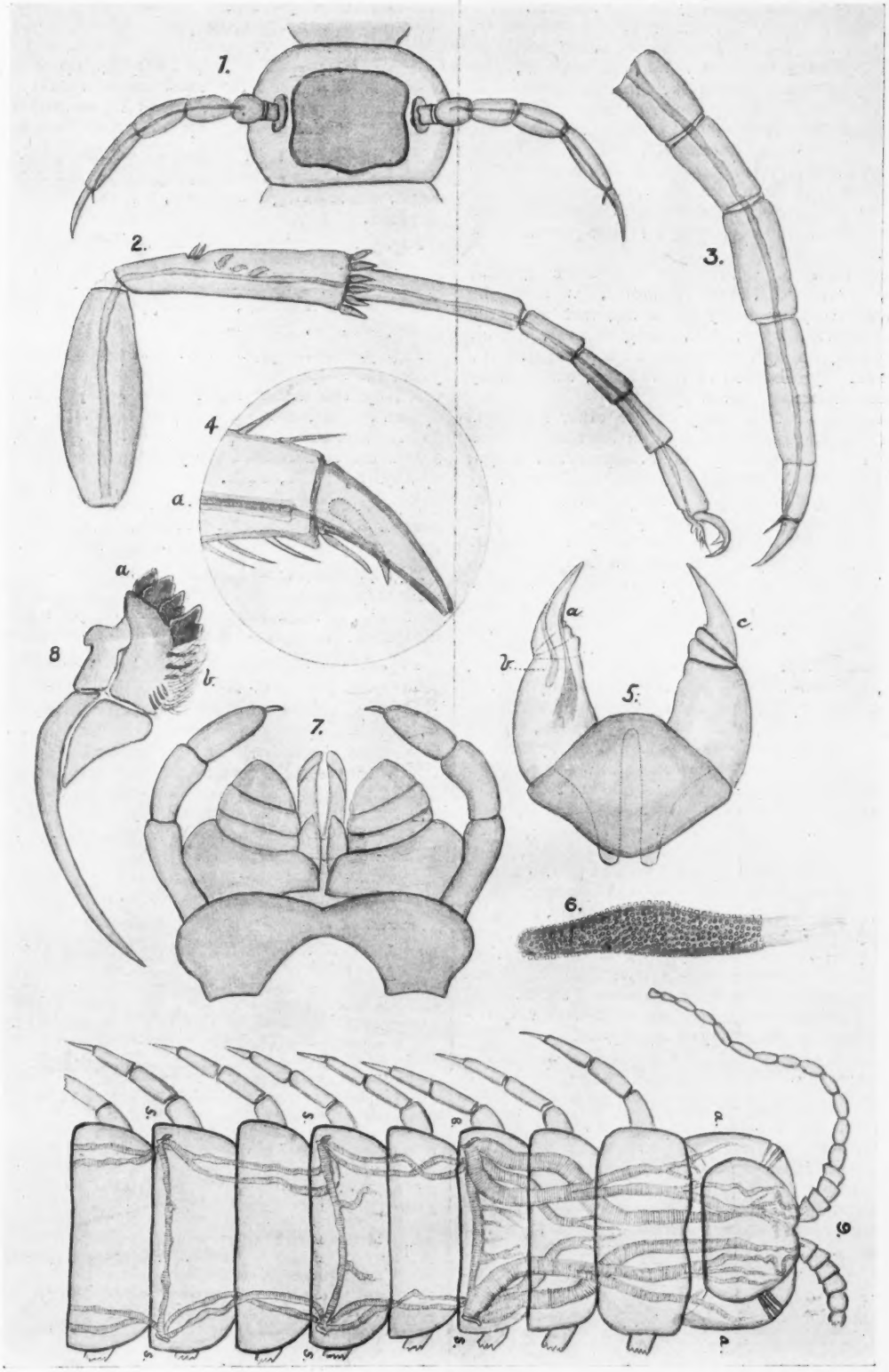
If we admit this homology, the question at once arises, how is it that the insects are hexapods and have three segments bearing limbs and forming the thorax, and a variable number forming the abdomen, which is without limbs, though furnished with appendages at the posterior extremity?

I think the answer to this question can also be found in the anatomy of the Chilopoda. The three segmented thorax of Insecta has mostly two pairs of spiracles. If a preparation of *Cryptops* is made showing the tracheal system, and this is not difficult,* it will be seen that the air trunks are nearly twice as large in the first three segments that follow the head, as in the remaining eighteen segments, and mark off or differentiate these three segments; also that the middle or second segment is without a spiracle.

Similarly in insects the middle segment of the thorax is mostly without a spiracle. Therefore I think that these three segments in *Cryptops* are homologous with the thorax of insects, the changes that have resulted in the fusion of segments and increase of size being intimately connected with the larger size of the air trunks. (Fig. 9.)

In two preparations of *Lithobius* in my collection the same conditions are met with, but the proportion of thickness of the tracheæ is less striking. In the *Scolopendra* from Kashmir the difference is exceedingly marked, but consists in a great number of air trunks

* Place the arthropod in 15 per cent. solution of potash for two days; examine it at intervals; as soon as the muscles are dissolved, the tracheæ can be seen clearly.



The Common British Centipede *Cryptops hortensis* Leach.

(eight to ten), while the remaining segments have not more than five tracheæ opening in each spiracle.

In the most highly organised orders of insects, Hymenoptera and Diptera, the thorax is differentiated from the abdomen in a very marked manner, and carries four spiracles, two in the anterior and two in the posterior part.* An approximation to this condition of the thorax is seen in the locusts and grasshoppers (Acrydiidæ and Locustidæ), while in the cockroaches and earwigs (Blattidæ and Dermaptera) the part, except that it carries the six legs, is not differentiated; so we have living examples of several conditions which have been passed through in the processes of evolution.

Another point of interest in the three genera, *Cryptops*, *Scolopendra*, and *Lithobius*, is that the spiracles are only on every other segment after the third; the fourth, sixth, etc., being missed, the air trunks passing through them without any outlet. We find the contrary condition in the insects, where every joint of the abdomen bears a spiracle.

The disappearance of many of the other segments and the complete loss of true legs on the abdomen has probably been occasioned by the development of wings; the absence of the spiracles from the intermediate segment of the Myriopoda and their presence on every segment of the abdomen in Insecta points out that they have played an important part in the ankylosis that has taken place. The origin of the wings is a matter on which several theories are held. Woodworth, in his Wing Veins of Insects,† has ably summarised them and inclines to the theory of Geganbaur formulated in 1870, that the wings are modified tracheal gills; but the anatomy of *Cryptops* will throw no light on this subject, and it is, therefore, outside the scope of this paper.

We can only say (*a*) that the antennæ of insects are homologous with the antennæ of the Myriopoda, (*b*) and the plate which supports them must necessarily also be homologous. (*c*) That the thorax and its tracheal system are represented by the three segments that follow the head of the centipedes; (*d*) that the insect legs are also homologous with the limbs on these segments. (*e*) It is highly probable that the anal appendages of insects are foreshadowed by the two last pairs of legs; that the other segments have been lost by a process of ankylosis, the two distal segments remaining, and that the true legs disappeared from the necessity of a flying insect carrying no unnecessary weight, three pairs of limbs being sufficient for ordinary powers of locomotion. (*d*) That the character of the air trunks of the tracheal system and the position of the spiracles were very important factors in the changes undergone.

EXPLANATION OF PLATE.

Fig. 1.—Diagram of the segment which follows immediately on the head of *Cryptops hortensis* Leach; viewed from the ventral side and showing one of the ventral plates. The legs are seen as transparent objects and show the "tendon" running through the joints and ending at the base of the claw. Drawn from a preparation made by the author, seen with a low magnification.

Fig. 2.—Fore-leg of *Dilophus febrilis* L. A Nematocerous fly, showing the five tarsi, tibia, and femur usually found in insects. Drawn diagrammatically to show the tendon running through the many joints and attached to the plate at the base of the claws. For comparison with the arthropod limbs and to show the absolute similarity of structure of the tendon in both Orders. *D. febrilis* belongs to the group of Diptera, which is considered the most archaic in type (the Nemocera or Nematocera), but is a genus of a family which I consider the most specialised in the group.

Fig. 3.—Leg of an undetermined *Scolopendra* from Kashmir. Drawn from a preparation for the microscope, and showing the tendon, and the greater number of joints.

Fig. 4.—Claw and end of the fourteenth leg of *C. hortensis*. Highly magnified and seen in optical section, showing the tubular nature of the tendon and its entrance into the claw, which appears to be perforated at its point. *a*, Tendon.

Fig. 5.—Outer jaws of *C. hortensis* and supporting plate; the shape of the under-side of the latter is indicated by the dotted lines. The left jaw is seen in optical section, to show the position of the tendon (*a*) and the sense organ or poison sac (?) (*b*). The right jaw shows the structure of the joints and is drawn as an opaque object. *c*, Claw.

Fig. 6.—Poison sac (?) or sense organ from the interior of the claw of *C. hortensis*, highly magnified to show the peculiar and characteristic structure.

Fig. 7.—Palpi, and labium-like organ situated immediately behind the outer jaws. Drawn diagrammatically, to show the structure of the joints, and with details of setæ, etc., omitted.

Fig. 8.—Left maxilla of *C. hortensis*, situated behind labium-like part (Fig. 7). *a*, Teeth; *b*, fans.

Fig. 9.—Head and eight following segments of *C. hortensis*. The dorsal plates are indicated, but are treated as transparent objects to allow the spiracles, which are on the connecting membranes, and the air trunks to be seen. Drawn diagrammatically to show the tracheal system; from a preparation made by the author and seen with a low-power objective. *s*, Spiracle; *a*, outer jaw.

NOTE.—The Cryptops were captured in a garden in the Adelaide Road, London, N.W.

* In some flies, such as the drone-fly (*Eristalis tenax* L), and in many of the Muscidæ the anterior spiracles have become highly specialised as vocal organs.

† University of California Pub. Entom. Vol. I., pp. 4-14.

THE *Electrical World* states that according to M. P. Bellile, a French naval surgeon on board the *Descartes*, which has been engaged in the campaign in Morocco, the members of the ship's company who were employed in wireless telegraph duty developed various affections in consequence of the action of the Hertzian waves. Most commonly the telegraphists complained of their eyes, a slight conjunctivitis similar to that occurring among those who work with arc lamps being found. Although this of itself was not generally serious, in one case where the attacks recurred again and again, keratitis was produced which resulted in a leukoma of the right cornea and consequent impairment of vision. In order to protect the eyes from the ultra-violet rays of electric emanation, it was recommended that yellow or orange glasses should be worn. Not only were the eyes of the operators affected, but two cases of eczema —one of the wrist and one of the eyelid, both very difficult to cure—were seen. One of the officials who had been employed for several years in wireless telegraphy suffered from a painful palpitation of the heart, which came on after working for any length of time at the instruments for sending messages. This man was quite free from any organic lesion of the heart. M. Bellile is disposed to think that a good many of the cases of nervousness and neurasthenia, which seem now to be getting rather common among naval men, may be due to the work which is being done in wireless telegraphy.

Factors in Organic Evolution.

I.—Convergence and Homoplasy.

By W. P. PYCRAFT.

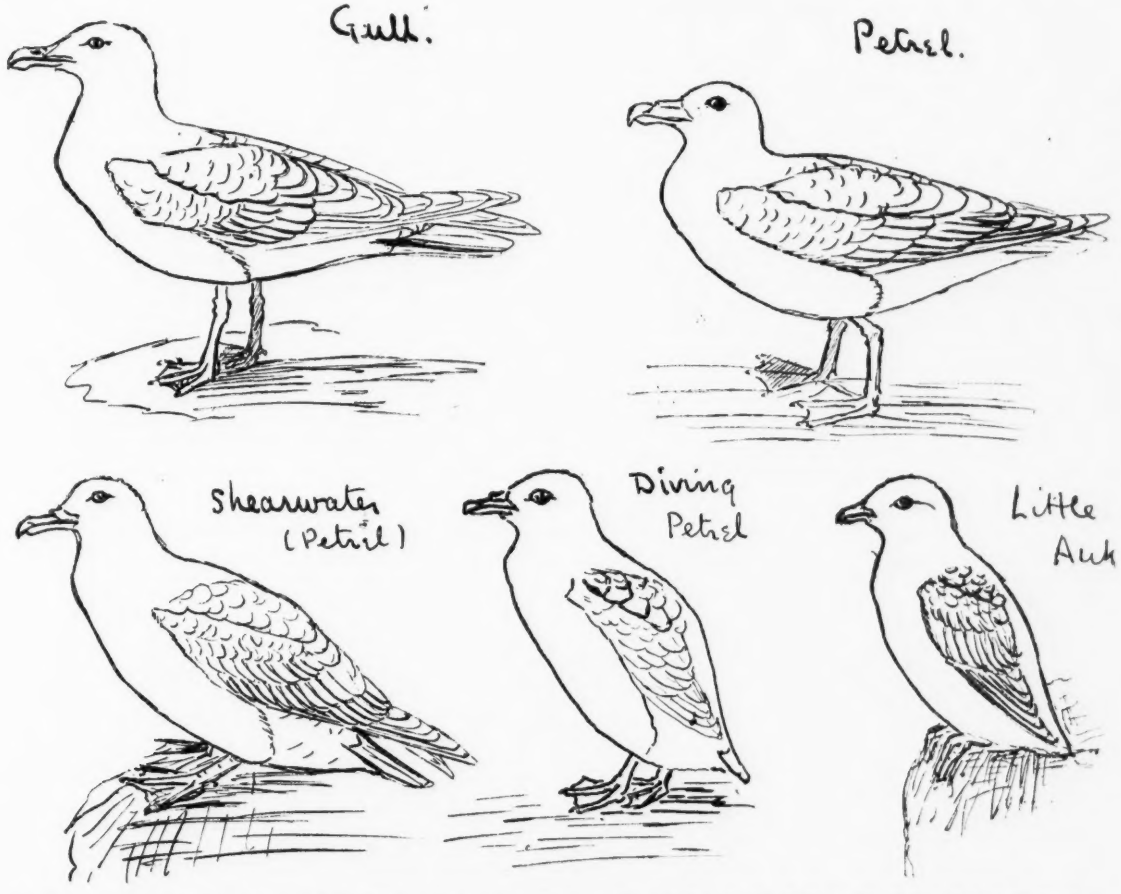
How greatly our methods have changed in the matter of the classification of animals since the birth of the "Origin of Species" may be measured by comparing the schemes of the older Taxonomists with those of Post-Darwinian times.

The earlier workers sought rather to bring together animals superficially similar for the purpose of convenient reference, than to express genetic affinity. Indeed, problems of affinity had scarcely begun to shape themselves. There was but a tacit assumption that the several types grouped together were more or less vaguely related. It is true, of course, that from the time of Aristotle onwards there was an implied relationship between the members of the larger groups of animals, but the idea of descent with modification and all that this entails had not then come into being.

Perhaps a few concrete cases and the lessons they convey will do more to make this clear than a laboured argument. From the vast number of illustrations that might be used in this connection I propose to draw one or two from among the birds; selecting, for the moment, such as concern external characters.

Take, for example, the Gulls and the Petrels. Even to-day there are ornithologists who regard these birds as nearly related; so much so, as to rank them as sub-orders of an order "Longipennes." And this because of the undoubted similarity of these birds in their external appearance.

The Fulmar Petrel and, say, the Herring Gull have an undoubted resemblance one to another, not only in general shape, but in coloration. Some of the Albatrosses, similarly, may be likened to huge Black-backed Gulls. The Petrel of the genus *Majaqueus* recalls the Skua Gulls, and so on. But the Petrels may always be distinguished from the Gulls by the fashion of the beak, for in this the sheath is always made up of a number of separate plates of horn, while the nostrils open into a tubular cavity on the ridge of the beak, or into a single tube, one on either side of this ridge. But matters of coloration apart, there is an undoubted likeness between the several species of the two groups, and if one looks no deeper there seems to be no good reason



Outline figures illustrating the superficial likeness between the Plover tribe and Petrels, the Gull and the Fulmar Petrel illustrating the forms which have retained full powers of flight, the Shearwater, Diving Petrel, and Little Auk the transformation in the shape and poise of the body brought about by the development of diving habits, and the consequent reduction in the powers of flight The legs herein have shifted further backwards to subserve the function of propellers.

why the two groups should not be associated, the "tube-nosed" forming one, and the Gulls, which have elongated nostrils pierced, as it were, through the middle of the beak from side to side, forming the other. In the number and coloration of the eggs, however, and in the character of the nestlings, the differences between these two groups are more striking. And it is one of the few achievements of the oologist to have drawn attention to the fact that in the matter of their eggs the Gulls closely resembled the Plovers. The very different character of the nestlings, however, has to this day escaped general comment. Petrels, of whatever kind, lay but a single egg, white, or faintly freckled at one end with pale red; and this is generally placed in a burrow, as is the case with most white eggs; but the Albatrosses build a nest, more or less columnar in shape, in the shallow cavity of which the precious germ is deposited.

When, however, we come to look beneath the surface, to make use of the dissecting knife, the true state of affairs becomes apparent. Then it becomes clear that, as the oologists surmised, the Gulls are nearly related to the Plover tribe, *are* Plovers in fact, which have undergone a very marked change of shape and coloration, and this, we must assume, in response to the more or less intangible demands of their environment, animate and inanimate.

The earliest Plovers, we may suppose, were marsh and fen-haunting birds, giving rise, in due course, on the one hand to what we may call desert-haunting types, such as Thicknees, Coursers, and Pratincoles, and on the other to estuarine and shore-frequenting types, of which the more striking examples are the Crab-Plovers and Sheath-bills—to take only the extremes from each group. From some one or other of the estuarine and beach-haunting types the Gulls may be assumed to have arisen, but though essentially marine birds, some make their way inland for considerable distances, breeding and spending much of the year inland. The Petrels, by way of contrast, are exclusively marine.

The Gulls are marine birds not merely in the sense of being haunters of the sea-shore, many species wander far out to sea; all have acquired the art of swimming, and in the case of one or two species, on occasion, of diving. And with the acquisition of increased swimming powers the feet have become webbed, while the hind toe has degenerated in some species to a mere vestige. All, at any rate, of the Plovers which frequent the neighbourhood of water swim, and some have semipalmated feet, but only one species seems to swim habitually. And this, it is significant to notice, is the beach-haunting, milk-white Sheath-bill (*Chionis*). Darwin, during the voyage of the *Beagle*, met with large flocks of Sheath-bills far out at sea. From some such stock we may assume the Gulls took their origin.

But why the transformation from the Plover to the Gull, if, as Plovers, they could venture thus far from land? One may, of course, with equal relevancy, ask why the different types of Plovers—Red-shanks, Curlew, Snipe, Turnstone, and a score others? These are questions more readily asked than answered, and, moreover, to attempt this would lead us too far from our present theme—the Gulls, in relation to the Petrels, to which last we must now turn.

The external characters and habitat of these birds we have already outlined. The study of their anatomy shows conclusively that they have no sort of relationship with the Gulls, but, rather, are related to the Penguins and Steganopodous birds (Gannets, Cormorants, etc.) on the one hand, and the Divers on the other. Now, these are all highly specialised birds, and hence we must assume that the Petrels are a very ancient group which split off from the ancestral stock before these more specialised types had begun to assume their present shape. The nature of the plumage, or, rather, the succession of the plumages in the Petrels, as compared with the Gulls, lends this view support. For in the last-named the adult plumage differs markedly from that of the young, immature bird; in some species, indeed, as in the Black-backed and Herring Gulls, the adult dress is not assumed till after the third year. In the Petrels, on the other hand, the difference between the immature and adult dress is but slight. This implies that the ancestral, immature plumage has become eliminated, a process which requires a relatively enormous time.

But besides the facts afforded by the plumage and by that earlier plumage known as the nestling-down, we have the evidence afforded by the muscular and visceral anatomy, and by the skeleton, both in its perfected state and during its development. Every scrap of information drawn from this source proves incontestably that the Petrels and the Gulls have nothing but a superficial likeness in common.

Very well. We must assume, then, that this likeness is the outcome of the action of external environmental forces, animate and inanimate, acting on structures fundamentally similar. That is to say, the ancestral Petrel and the ancestral Gull had much in common in the shape of length of leg and wing and in their mode of life, and this is not surprising, for it is certain that the Divers, Penguins, and Steganopodous birds can only have acquired their several peculiarities as a consequence of specialisation—by the excessive development or exaggeration of slight peculiarities of a common framework.

In other words, the Gulls and Petrels are convergent forms; are what Sir Ray Lankester calls "homoplasts." When, he contended, some 40 years ago, organs similar in plan and function, in unrelated animals, are subjected to like environmental influences, they tend to assume the same shape. Now birds, whatever their apparent differences, are really more uniform in structure than any other group of vertebrates; a uniformity traceable to the exigencies of flight; and it is certain that this uniformity must have been even greater during the earlier phases of Avian Evolution. The Petrels, while "converging" towards the Gulls in external form, owing to their similar mode of life, were at the same time diverging in all other particulars of their anatomy which did not come within the sphere of this moulding force. In, for instance, the details of the structural characters of skull, sternum, and shoulder girdle, in their muscular anatomy, in the matter of the peculiarities now apparent in the alimentary canal, and, in particular, in the evolution of the stomach and convolutions of the intestine, and in the peculiar character of the beak sheath. These points of divergence were matters of internal policy, so to speak, and did not come under the sway of the external environment.

But the Plover tribe and the Petrels afford yet other evidences of "homoplasy," of convergent development. For just as the similar mode of life pursued by the Gulls and Petrels, such as the Fulmar and Albatross, has brought about a similar external shape, so we find similar habits have brought about a resemblance no less striking between the Petrels and the Auks! This likeness is found between the Little Diving Petrel, *Pelecanoides*, and the Little Auk; a likeness so striking that the one has more than once been mistaken for the other. In the evolution of this form we have a sort of halfway house in the Shearwaters. These are Petrels

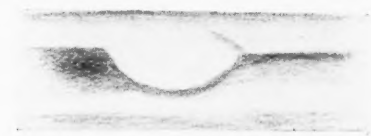
which obtain much of their food by diving, wherein they differ from the Gull-like surface-feeding forms. In adaptation to this more strictly aquatic life the body has assumed a relatively longer shape, while the legs, from the shortening of the femora, are brought nearer the tail. This change is very obvious when these birds are compared in a standing position with the more typical Petrels. In the Little Diving Petrels this backward shifting of the leg is still more marked, so that the body, when resting on land, assumes a nearly vertical position as in the Auks and Guillemots! Now, like these last the Diving Petrels fly but little, but spend most of their time afloat, and obtain all their food by diving. Hence we can trace the stages by which one branch of the Petrels has come to resemble the Auks, though we are unable to do as much in regard to the likeness of that other branch to the Gulls. But we may safely assume it followed similar lines.

Recent Observations of Jupiter.

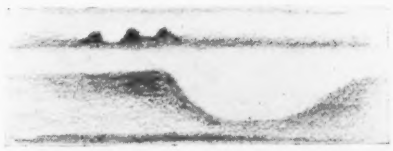
By IRENE E. TOYE WARNER.

I OBSERVED the planet Jupiter on thirty-three evenings during the last apparition in 1909, and made fifty-six drawings, of which number three are reproduced in this article. The instrument used was a 12.6 inch Calver reflector, mounted on a pillar stand, in the open air. Perhaps the chief attraction about the planet is the rapidity with which his scenery varies and the consequent necessity for careful study and numerous drawings.

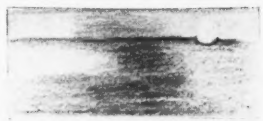
Feb. 22, 9h. 5m.



Feb. 24, 11h. 10m.



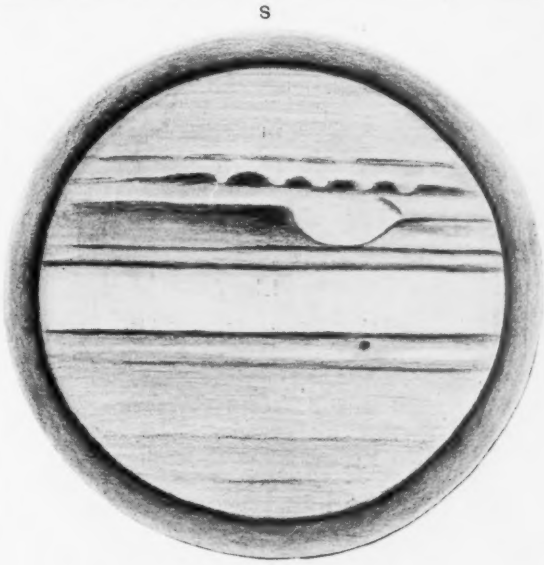
March 15, 10h. 55m.



March 17, 8h.

April 6, 10h.

One of the most noticeable features on Jupiter's disc last spring was the extreme whiteness of the equatorial zone, it being—with the exception of occasional spots in the southern hemisphere—by far the most brilliant marking observed. I only saw shadings on the zone on one occasion—May 29 at 8h. 50m.—when some very faint, dusky material from the north and south equatorial belts apparently spread over that region and dimmed its lustre for a time. A well-known and experienced observer, the Rev. T. E. R. Phillips, F.R.A.S., noted the unusual faintness of the markings, and found that the very best seeing conditions were necessary to show this elusive detail. The northern edge of the south equatorial belt and southern edge of the north equatorial belt were very sharply defined and of a dark brown tint during February, March, and April, but on May 2 I noticed that they



April 4, 7h. 35m.

seemed more hazy and irregular in outline. Especially was this the case with the north equatorial. The equatorial zone also appeared to be narrower than formerly.

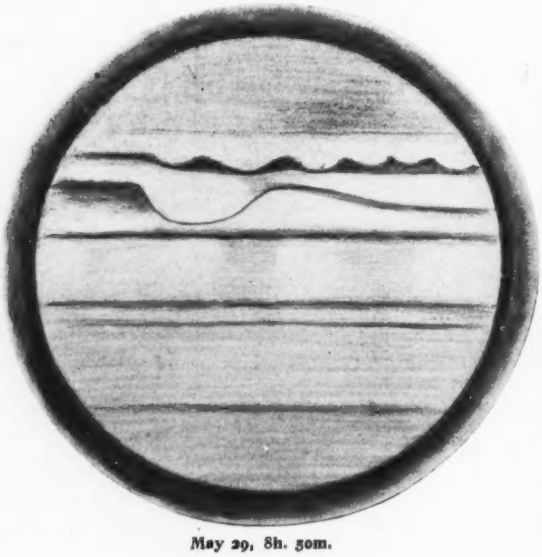
The drawing of April 16 shows a few of the remarkable dark and light spots which broke out along the north edge of the N.N. temperate belt; they were not seen often, owing to bad definition.

The Red Spot Hollow has varied in form very considerably almost from night to night, the development of the "following" shoulder being extremely rapid as will be seen from the accompanying drawings of that region. The "preceding" shoulder has been very dark, especially in March and April, but it has not changed much during this apparition. The "following" shoulder, on the contrary, was often very faint. On April 4 a beautiful pencilled arm connected the "following" shoulder with the S. temperate belt; on the 6th this sharply defined line had become dispersed and faint. It seemed to have spread out into a cloudy mass sweeping over the S. tropical zone and joining the S. temperate belt. On the 9th it had grown fainter and the cloudy material had disappeared; on the 16th all trace of the arm had vanished, and I did not see it again

until May 29, when an extremely attenuated wisp was just visible in the place where the arm had been, but even this seems to have gone (possibly owing to bad definition) when I observed the Hollow on June 7.

On March 17 at 8 hrs. I noticed that some of the large dark mass, which is one of the most noticeable features on the planet, had drifted over the S. temperate belt and S. tropical zone into the S.S. temperate belt. The S. polar regions have been generally very dark, especially, I think, during May. The whole

April 16, 10h. 20m. Calver 12·6 in.



May 29, 8h. 50m.

northern hemisphere, with the exception of a few white spots, has been shaded right to the N. pole.

The S. temperate belt has been in a very active state, numerous bright and dark spots being crowded along its southern edge. On May 23 between 8h. 30m. and 9h. 15m. I saw an enormous white marking, like a miniature Red Spot Hollow, in the S. temperate belt, preceded by smaller spots. Between the N. edge of the N. equatorial belt and the Spot Hollow the white zone was always very clear, whilst in 1908 all this region was filled with dark material.

CORRESPONDENCE.

Ornithology.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—I am sorry to see from a letter in your issue of August that Mr. Pycraft so strongly condemns the action of myself and other proprietors in turning out rypes in Scotland. Mr. Pycraft should remember that, in using such words as "mischievous," "selfish," and "without cause," he is only expressing his own opinion.

Not being a sportsman himself, Mr. Pycraft seems able only to look at our endeavours to improve sport from the standpoint of science, mixed with sentiment. In my opinion, there is far more selfishness shown by scientific faddists who would turn out birds of prey, which, when left to become numerous, must necessarily interfere with other interests, and have little chance of escaping from keepers or collectors, in any case.

Looking at the case from a scientific view only, Mr. Pycraft may be right, though I do not think he is. The rypes and our red grouse are identically the same bird, though disease has never been known in the former, and even interbreeding with the red grouse, to the limited extent they are ever likely to do, should do more good than harm.

The rypes do not care to roam far from the scrub or woods, and should make for increased bags, and therefore higher rents, especially on shootings where black game have almost ceased to exist. Unfortunately, scientists like Mr. Pycraft do not care for this practical side of the question.

As far as my own "selfishness" goes, it has consisted in spending a good deal of money to try and improve my own and other people's shootings. No one loves birds more than I do, but there is a line where fads, either scientific or sentimental, should stop.

I am, yours, etc.,
W. STEUART MENGIES.

[Mr. W. Steuart Mengies adopts the common and vulgar practice of branding what he does not understand as "faddism." I had fondly imagined that such foolish expressions as "scientific faddists," and all that they connote, were not now used by those who claimed to be regarded as educated men. But I find I am mistaken.

Abuse is not argument; but Mr. Mengies is scarcely qualified to argue about this matter of the introduction of ryper into these islands, for he has yet to learn that the ryper is *not* identically the same bird as the British red grouse. Hence my objection. The latter has, by long isolation, acquired characters wherein it differs from its Continental relative, and conspicuously, in the fact that it does not assume a white dress in winter.

Mr. Mengies' mischievous—I must repeat the term—experiment may end in exterminating this peculiarly interesting geographical race. He further shows but little insight into the habits of the bird he has introduced, when he assumes that they will do just what he expects them to do; that they will keep the bounds he has set for them, as well in the matter of habitat as of interbreeding.

He cannot even defend his position from the point of view of the "sportsman," for Scotland is already well supplied with game, and with intelligent management the decline of the black game, which he deplores, could be stopped. The benefit to "sport" which he seems to imagine will accrue from his folly is *nil*. Any sportsman will, moreover, tell him that the bird he has so mistakenly introduced is far inferior to our native bird in several ways, and especially in the quality of its flesh.

Mr. Mengies, however, gives away his case by remarking: "Looking at the case from a scientific point of view only, Mr. Pycraft may be right." I am not, as Mr. Mengies gratuitously assumes, concerned with that sentimental aspect of the case which he seems to have discovered. I fail to see, myself, where the sentiment comes in.

If there is anything of "faddism" in this matter Mr. Mengies is the guilty party; for the benefit that he assumes would follow from his unfortunate experiment is purely imaginary, and born of an inability to grasp the lessons of eugenics; while the mischief that will accrue is very real.

W. P. PYCRAFT.]

Some Notes on the Bee

Anthidium Manicatum.

By G. W. BULMAN, M.A., B.Sc.

I.

I OWE my introduction to this interesting bee to the growing of certain species of Linaria. These (*L. maroccana*, *L. bipartita*, and *L. reticulata*) are very elegant little flowers, and well worth growing for their own sake. I have reason to believe that I was the first to grow them in this district, and that they were therefore new to the wild bees of the neighbourhood, but *Anthidium manicatum* found them out, and on their flowers I saw this bee for the first time. It is the only species of the genus, represented by numerous species in the South of Europe, occurring in this country. It is one of the easiest of our wild bees to recognise, from the unique fact that the male is conspicuously larger than the female. They are usually to be seen together, and the industry of the latter readily distinguishes her from her idle partner. The former is also remarkable for his bewildering rapidity of flight. A flowering patch of Linaria is a potent attraction to bring this beautiful insect to our gardens. The male chooses a patch of purple or rose-coloured flowers, over which he darts in rapid flight ready to chase away all rivals. Every now and then he pays a brief visit to a flower, so brief, that it is difficult to think he gets even a sip of nectar. Occasionally he rests for a few seconds on the ground panting hard after his exertions. But here is a smaller brown bee, prettily marked with yellow, working the Linaria flowers at a rate which puts the hive bee to shame. Her movements are closely followed by her mate, who makes frequent d shes for her as she passes from one flower to another.

And well may this industrious little bee thus flit rapidly from flower to flower. Before her lies the stupendous task of providing a sufficient store of honey and pollen to feed her numerous offspring, whom she will never see, through their grub stage. But even this is not all. Having chosen a site for her nest, the tunnel bored in tree or old paling by a beetle, she must line the cavity. So she goes to the woolly hedge-nettle (a species of *Stachys*) or other suitable plant, and scrapes off the cottony down. Rolling it up into a ball she carries it off to the chosen spot, and lines the cavity with it. Then an egg is laid, the cell is provisioned with sufficient honey and pollen for the grub life of the young bee, and sealed up. So she goes on until each egg is provided for. The young grub having eaten up the store of food, spins itself a covering of brown silk, and remains a chrysalis through the winter and spring. It emerges, probably in June or July, to haunt the Linaria flowers of another year.

Such was my introduction to *Anthidium manicatum*. This year another species of Linaria has offered me even greater opportunities of studying its curious habits. The new Linaria (*L. dalmatica*) is a perennial with numerous spikes of yellow flowers each with a patch of orange on the lip, and growing about 5 feet high. Behind a single plant of this is a hollyhock about 10 feet high, with numerous branches and flowers of a sort of light purple colour. To the right is a patch of purple Linaria—probably *L. bipartita*. Such is the *mise en scène* where I have spent many interesting moments in watching the ways and manners of *Anthidium manicatum*. My attention was first attracted by seeing some bees dusted with the light-coloured pollen of the hollyhock on the yellow Linaria. After watching them for some time I realised that they were *Anthidiums*. But the rapidity of flight of the male scarcely impressed me so much as on previous occasions. And certainly he seemed to spend more time in feeding, for he would sometimes visit four or five flowers in succession, and spend an appreciable time in each.

A male *Anthidium* takes possession of the bush of yellow Linaria, and darts hither and thither among the flowers in search of the female. The latter is working away industriously on the flowers unheeding his presence. If the male sees her he darts for her, but often fails in his attempts. But now he gets just behind her as she is working with head inserted in the flower. Poising himself carefully he, so to speak, shoots himself at her. If she holds on to the flower he succeeds in his attempts, and they remain together for perhaps 10 seconds. He then flies off, and she continues her interrupted work on the flower. Not infrequently, however, the female leaves hold of the flower, and the two fall together. The male is obliged to leave go, and thus fails in his attempt. With regard to this matter of the fertilisation of the female, Schuckard, in his work on bees, says: "So boisterous is he in his amours that he forcibly conveys his partner to the upper regions of the air, where she is compelled to yield to his solicitations."

Professor Plateau, of the University of Ghent, however, confirms the above observation that union takes place on a flower.

After carefully patrolling the Linaria, the male flies off to the hollyhock. There is a big humble bee in one of the flowers, and he dashes at it. The alarmed humble bee flies off in haste, making wide circles in the air. Now our *Anthidium* is back again carefully searching the Linaria flowers. Failing to find the female, which is working there, he is off again to the hollyhock, and dashes wildly at two or three hive bees which are working there. The alarmed and puzzled bee generally makes off at once. If it refuses to take the hint *Anthidium* insists firmly on seeing it off the premises. He chases one in and out among the hollyhock branches, and pursues another over the wall out of the garden. Then he is back to the yellow Linaria to sip honey from a flower or two. Now a brief visit to the purple Linaria below, and ever as he buzzes his devious way among the branches it is a case of *cherchez la femme*. Sometimes he makes his characteristic dash at a flower as if he saw a female on it.

But now another male presumes to approach, and there is much angry greeting. They face each other in the air in a threatening way. They advance and retreat, always keeping face to face. Every now and then they dash fiercely at each other, and there seems to be a brief struggle. If one turns away the other swiftly pursues. Finally, one is driven off, and the victor is presently patrolling the Linaria alone. At times he rests for a brief moment on the wall, the ground, or a hollyhock leaf, panting hard after his exertions. And he seems to pant hardest after an encounter with another male. So he goes on through the hot hours of the summer day. Now with breathless haste in and out among the Linaria flowers. A few sips of honey from the blossoms, and. perhaps, a few seconds with a female on a flower. Then dashing frantically among the hollyhock blossoms disturbing the hive and humble bees, and driving them over the

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wall in hot haste. Then back to the Linaria. Hollyhock, Linaria, hollyhock, Linaria, rest, Linaria, hollyhock, and so on in endless alternations. I left him thus in the morning, and at four o'clock in the afternoon he was there still buzzing away among the yellow Linarias. But the females seemed all to have gone.

Once when I visited his little kingdom of flowers in the afternoon I found my male *Anthidium* behaving in rather a foolish way. He was carefully going over the purple Linarias searching for a female, and often making a little characteristic dash at a flower as if he saw one. Yet there was not a single female among these flowers. But close at hand, a little higher up, there were three busy among the yellow Linarias. All the time I watched him he kept obstinately to the purple flowers where there were no females.

The next day again he seems possessed with a strange spirit of perversity. He goes backwards and forwards, searching persistently from the patch of purple Linaria on the right to some scattered plants of the same on the left. Backwards and forwards he goes again and again. Yet there is not a single female among these blossoms, while all the time they are busy among the yellow Linarias above. Another visit shows him acting in the same perverse way.

Some years ago Professor Plateau made some interesting studies of this insect, and published his results in the *Annales de la Société Entomologique de Belgique*. His chief conclusion from observing it on a bed of *Salvia Horminum* was that this bee's vision is defective as regards stationary objects, though good for objects in motion. It is admitted that a superficial observation would lead to the conclusion that *Anthidium* possesses a very keen sight; but the female, Professor Plateau points out, will often fly off and return to the very flower she has just visited, as if she took it for a fresh one. This, indeed, is common with most bees. *Anthidium*, again, was observed to go to flowers partly faded, and sometimes to fall to the ground with the partially withered corollas. They would also try in vain to work unopened flowers. As regards the male, Professor Plateau's chief indictment against it in the matter of vision is that it frequently mistakes other insects for its own female. He has seen it precipitate itself on three other species of bee, including the hive bee, apparently mistaking them for females of his own species. On one occasion on my yellow Linaria I saw an obvious attempt of this sort on a hive bee. The latter had come down from the hollyhocks, and was attempting to work a Linaria flower. *Anthidium* came behind, and hovered close to it in its usual way. Then it darted at the hive bee, and seized it as it would its own female. The hive bee let go its hold of the flower, and they tumbled down together. In a second or two the *Anthidium* was again buzzing round the Linaria flowers. This seemed to be a clear case of mistaking a hive bee for a female *Anthidium*. But in the dozens of cases in which I have seen the male *Anthidium* hurl himself at hive and humble bees among the hollyhock blossoms, I am convinced that he was merely driving them away. And it must also be said in his favour that he always seems to recognise a male of his own kind.

Again, Professor Plateau notes that in flying about the male *Anthidium* will often pass quite close to a female on a flower without perceiving her. This has been abundantly verified in my experience. I have seen a male go carefully round the Linaria flowers on which three females were working without perceiving them. He would leave them and go to chase hive or humble bees among the hollyhocks.

Another error according to Professor Plateau, also due to defective vision, is that he will make a second attempt on an already fertilised female. "I have seen," he says, "a male deceive himself twice in succession with regard to the same female. These attempts were, of course, abortive." And I have on many occasions seen a male *Anthidium* make such useless attempts. Now Professor Plateau's idea that the male deceives himself of course implies that, as in the case of the hive bee, only one union normally takes place. But from the number of times I have seen a male *Anthidium* successfully accomplish his object in a short time on my plant of yellow Linaria, I am inclined to infer that a female *Anthidium* is normally fertilised several times. In order to put this view to the test I have kept a particular female in view as long as possible. Very soon a male saw her and fertilisation took place. Following her movements carefully I saw four or five other attempts on her, one of which was almost successful, that is, they remained together for two or three seconds. And in many of the frequent unsuccessful attempts that take place the reason of the failure is that the female leaves hold, or is forced to leave hold, of the flower. The two tumble together and the male is compelled to release her. On another occasion, keeping a particular female in view, I saw the male successfully accomplish a second union on the Linaria in a short time. They remained together in each case the usual ten seconds on the flower.

In his interesting "Observations sur le Phenomene de la Constance chez quelques Hyménoptères," Professor Plateau says of *Anthidium manicatum*:—

"The insect is very constant, and it is only with considerable trouble that I have been able to collect the eight cases of inconstancy noted in the following table."

What bearing have the above observations of this bee on this important question? In my garden they have been very constant to the Linaria. The first year they came I never saw them except on the annual species, but then there were *three species* of these, and the bees passed freely from one to another.

This year, again, they have been remarkably constant to Linaria. Yet, as noted above, the male for long periods went systematically from yellow Linaria to hollyhock, and often came back to the former dusted with hollyhock pollen. The females working on the Linaria were also often whitened with the same. At other times the male would systematically go from a patch of purple annual Linaria to the yellow perennial one. The females also, though less frequently, passed from one to the other.

NEWTON'S CATALOGUE OF LANTERNS AND SLIDES.—The usefulness and importance of the catalogues of lantern slides and apparatus which are periodically issued by Messrs. Newton and Co., 3, Fleet Street, are so well known that it is hardly necessary to do more than call attention to the new number just issued at the price of one shilling. Forty-five pages are devoted to magic lanterns and dissolving view apparatus of every kind; forty pages more to scientific projective apparatus, etc.; and no fewer than 400 closely-printed pages to the many thousands of optical slides dealing with nearly every subject known to science or engineering which Messrs. Newton have collected. The catalogue is itself of great value and interest.

Solar Disturbances During September, 1909.

By FRANK C. DENNETT.

DURING September there has been a remarkable revival of solar energy, not so much in the number, as in the magnitude of some of the outbreaks. The longitude of the central meridian on September 1, at noon, was 240° 51′.

No. 92 remained visible until September 7, and, therefore, appears on the present chart.

No. 92*a*.—A pore 60,000 miles west of No. 92, only seen on 3rd.

No. 93.—Broke out as a line of pores, 66,000 miles long, on 5th, but by next day its preceding member was 18,000 miles in diameter with two umbræ. The group was like a double chain on 8th, and by next day the leader had increased to 27,000 miles in diameter, the rear one presenting much the form of a section of an orange. The inner edge of the penumbra of the leading spot appeared fringed with brightness on September 6, 7, 9, and 12. The group was of a very protean character, attaining a maximum length of 90,000 miles. It remained visible until 14th.

Sept. 26, 2.55 p.m.

No. 93*a*.—Developed north of No. 93, in nearly the same longitude, on 6th as a group of three pores, 22,000 miles in length, and by next day it had doubled this length. Its maximum was 80,000 miles, the largest member being 45,000 miles in diameter. Last seen on 14th.

No. 94.—Two pores 30,000 miles apart on 12th, one remaining until next day.

No. 95.—A somewhat lozenge-shaped group of half a dozen pores on 12th and 13th, 26,000 miles in length, almost faded 14th, but revived as two pores 15th and 16th.

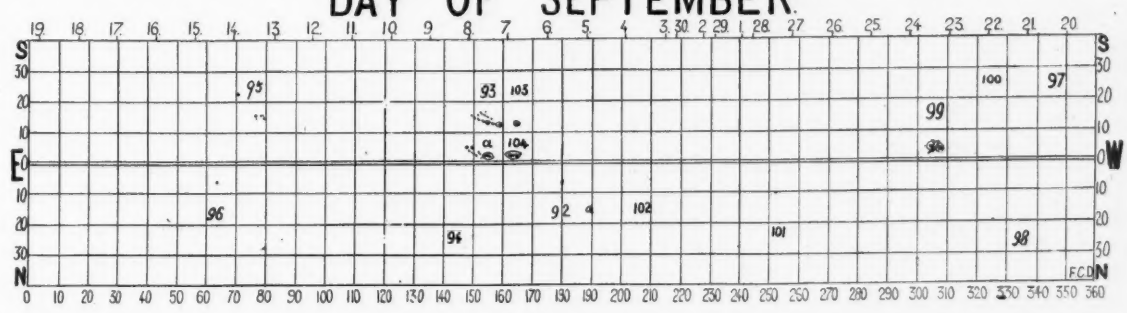
No. 96.—A pore only seen on 15th. On 19th and 20th some pores were seen, but not measured, about 8° west of this spot.

No. 97.—A solitary pore, also only observed on 15th.

No. 98.—Two pores, 58,000 miles apart, seen 15th to 20th, attaining a maximum on 18th.

No. 99.—Two larger spots with a smaller companion on 18th, a dense penumbral mass developed amid them and joined all into one large spot by 20th. The umbræ on 22nd seemed to be violet-black in colour, the penumbra appearing brownish. From time to time the spot and its surroundings showed considerable activity in the spectroscope. On 25th the spot had assumed a distinctly cyclonic character by 1.30 p.m., certainly not noticed in the morning. Something of the same character was still noticeable when Mr. W. F. Denning drew it on 26th, and changes in its structure were still taking place very rapidly. On 27th it had altered very much. Last seen on 29th. The penumbra bright fringed round both umbræ on 19th and 20th.

No. 100.—Two spotlets, 66,000 miles apart, having one or two pores between on 20th. On 22nd there were five forming a curve concave to the south pole. Its appearance much altered on 24th, but its area continued about the same until 26th, when faculæ were seen round, and on 27th only one pore remained, at rear of a considerable mass of faculæ. Not seen again.



No. 101.—Two tiny pores near the east limb on 22nd, one continuing visible on 23rd and 24th.

No. 102.—One pore on 29th, a group 45,000 miles in length, consisting of two pairs on 30th, one pair remained on October 1, and one pore was last seen on 2nd.

No. 103.—Evidently a return of 93, although it appears to have gained somewhat in longitude; seen from September 29 till October 10. The diameter was 14,000 miles at first, but dwindled afterwards. A delicate bridge crossed the umbra on 6th, and it was alone, except on 2nd, when two tiny pores were east and south-east.

No. 104.—Appears to be a return of 93*a*, but to have also increased in longitude. Its diameter increased from 30,000 miles on October 2, to nearly 45,000 miles on 4th, when the following, or eastern, of its three umbræ was brightly bridged. Visible September 29 until October 10.

The chart is, as usual, constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, and the writer.

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NOTES.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S., F.R.A.S.

RETURN OF HALLEY'S COMET.—On September 11, 1909, Professor Max Wolf, at Heidelberg, detected the image of Halley's comet on a photograph taken (presumably) with the Bruce telescope of the Konigstuhl Observatory. It is extremely satisfactory to learn that the comet was found in very close proximity to the place predicted in the ephemeris computed by Messrs. Cowell and Crommelin. Photographs of the region obtained at Greenwich with the 30-inch reflector on September 9 also show the comet, but this was not recognised until the definite news came from Professor Max Wolf. The closeness of the predicted positions will be seen from the following comparison :—

	R.A.	Decl.
Position at $14^h\ 7{\cdot}3^m$ Konigstuhl Mean Time	$6^h\ 18^m\ 12^s$	$+17^\circ\ 11'$
Computed from Cowell and Crommelin's Ephemeris	$6^h\ 18^m\ 4^s$	$+17^\circ\ 16'$

Subsequently photographs were obtained at the Lick and Yerkes Observatories, and from the positions thus available a corrected ephemeris has been prepared.—(A. C. D. Crommelin, *Observatory*, October, 1909, p. 400.)

EPHEMERIS FOR OBSERVATIONS OF HALLEY'S COMET AT 8.40 P.M. GREENWICH MEAN TIME.

	R.A.	Decl.	Mag.
1909, Nov. 1 ..	$5^h\ 51^m\ 40^s$	$+16^\circ\ 52'$N.	14·0
,, 6 ..	5 42 33	16 49	13·7
,, 11 ..	5 31 32	16 44	
,, 16 ..	5 18 33	16 38	13·2
,, 21 ..	5 3 23	16 26	
,, 26 ..	4 46 13	16 13	12·7
Dec. 1 ..	4 26 56	15 52	
,, 6 ..	4 6 13	15 23	12·3
,, 11 ..	3 44 24	14 45	
,, 16 ..	3 22 19	14 4	11·9
,, 21 ..	3 0 34	13 18	
,, 26 ..	2 40 11	12 28	11·7

REVISED ELEMENTS.

Peribelion passage	1910, April 20
Longitude of Ascending Node..	$57^\circ\ 16'\ 12''$
Node to Perihelion	111 42 16
Inclination of Orbit	162 12 42
Semi-major Axis of Ellipse ..	17·94527
Eccentricity	0·967281

Dr. Downing thinks that from the observed photographic magnitude of the comet it should be visible to the eye with a telescope of about 12 inches aperture. On October 15 its magnitude was about 14·5, its distance being about 230 million miles. At the beginning of November it will be almost in the continuation of the line through ξ and ν Orionis, and nearly north of the red star Betelgeuse (α Orionis). Of course, it is possible that the comet may be specially rich in blue and violet radiation, as was the case with Comet Morehouse, and not be easily visible to the eye at present even with considerable optical aid. Situated near the northern border of the Constellation of Orion it will be excellently adapted for observation after midnight throughout the next two months. It is calculated to be approaching the earth at the rate of about 1,500,000 miles per day.

Mr. Crommelin finds that there is great probability that the comet will transit the sun's disc some time next spring (about May 18), and this suggests the interesting problem of attempting to photograph it by means of the spectroheliograph. If we are fortunate enough to become familiar with its spectrum in the near future, it will be possible to suggest what wave-length should be transmitted by the secondary slit of the instrument, and it is hoped that by the relative intensification of the special cometary radiation some indication of the nucleus and coma may be photographed. A detailed ephemeris for this will be furnished later.

WATER-VAPOUR ON MARS.—During their stay on Mount Whitney, Messrs. Campbell and Albrecht obtained spectrograms of the Moon and the planet Mars on September 1 and 2, 1909. Special precautions were taken to ensure equal atmospheric conditions for the two objects, the zenith distance being 42°; barometric pressure 450 mm.; air temperature -1° C.; wet bulb thermometer -8° C. Under these circumstances they found spectroscopic evidence of only a very small quantity of water-vapour, and the bands indicated that the intensity was about equal in the spectra of the Moon and Mars, thus indicating that in the atmosphere of Mars there is probably no more water-vapour than is present on the Moon's surface.

SOLAR DISTURBANCES AND TERRESTRIAL MAGNETIC STORMS.—Considerable interest attaches to the astronomical (apart from the meteorological) aspect of the great disturbances of the earth's magnetic field, which from time to time are evidenced by almost complete dislocation of the telegraph service, and often accompanied by brilliant displays of Aurora Borealis. The storm which occurred on September 25, 1909, was one of special significance, inasmuch as it was the greatest since the memorable one of October 31, 1903. Dr. Chree states that the violent portion of the storm commenced at 11.43 a.m. on the 25th, and the oscillations of great amplitude continued until 8.30 p.m. of the same day. Many of these carried the needle from 98° W. to 84° E. It has previously been noted that these strongly oscillatory disturbances are associated with the most brilliant auroræ, and this was so in this case. Observations in various parts of the country confirm the intensity of the glow, and those who were fortunate enough to get spectrum observations report that the green line was strongly visible; in some cases several extra lines were observed.

Numerous attempts have been made to trace some connection between these magnetic storms and solar phenomena, as evidenced by the prevalence of spots or prominences. It has very frequently happened that at the time of occurrence of a magnetic storm there has been a large disturbance near the central meridian of the sun, and from the discussion of all such observations over a long period, Mr. E. W. Maunder has found evidence of a recurrence of magnetic disturbances very nearly commensurate with the time of the solar rotation. This led to the reconsideration of the idea of radial emission of some medium from the solar surface, which, passing outward through space, would induce magnetic effects on all bodies in its path. If it was so directed as to strike the earth, we should have a magnetic storm; if it missed, then the magnets would remain undisturbed. This view would suffice to explain the rather numerous cases where very violent areas of disturbance have been present near the central solar meridian without any corresponding terrestrial magnetic storm having been detected. In the present instance there was a large spot group a little west of the sun's meridian, and spectroscopic evidence of several workers showed that it had been in violent disturbance from the time it came round the east limb. Whether these phenomena are related as cause and effect, or are both the results of some cosmical action not yet recognised, can only be determined by continued patient observations.

RECENT OBSERVATIONS OF SATURN.—Professor Lowell reports that observations at Flagstaff give evidence of remarkable changes in the physical features of Saturn. The surface is marked with faint belts, which frequently show rose-coloured tints; in general, there is seldom any definite marking. On the equator a dark medial streak has been seen, with indication of a lacing structure similar to that

sometimes seen on the disc of Jupiter. Occasionally white spots appear, and observations of these afford an opportunity of determining the rotation period with considerable accuracy; one of these, intensely brilliant, was in transit across the disc on September 23, 1909.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

ANCIENT EGYPTIAN FABRICS.—An examination has recently been made by Mr. J. Hübner of the bandages unwrapped from two mummies of the 12th dynasty (about 2500 B.C.). Microscopical examination of the fabrics showed that both warp and weft consisted of linen, but that the fibres differed from those in modern linen fabrics in the fact that the characteristic bulbs on the flax fibres were frequently torn or burst, and resembled those on linen fibres that have been passed through a beating engine in the manufacture of paper. In the case of the fibres in the mummy linen, the torn bulbs were probably the result of chemical disintegration.

Some of the bandages were undyed, while others were of a bright yellow colour, and in others, again, a brownish-yellow pigment was present. In the wrappings of mummies of a later period the occurrence of other colours, such as red, blue, etc., is frequent, but in these bandages yellow was the only colour present.

The undyed bandages contained a high percentage of moisture (up to 9.1 per cent.), and a large proportion of mineral matter (up to 19.8 per cent.), and from this it would appear that the art of loading textile fabrics was not unknown to the ancient Egyptians. In the dyed fabrics the amount of ash (1.7 to 3.7 per cent.) was so small as to indicate that there had been no impregnation of the material with mineral matter after dyeing. In each case the ash was found to contain alumina, which confirmed the results of previous investigation as regards the use of aluminium salts as mordants for vegetable dye-stuffs in ancient Egypt.

Some of the wrappings had been well darned, and this supported the view that old linen cloths were employed for this purpose. Against this, Mr. Hübner points out that the even distribution of the yellow dye in the coloured bandages indicates the probability of their having been specially dyed for the occasion.

The yellow dye-stuff could be readily extracted from the cloths with water. It agreed in its reactions and in the results of comparative dyeing tests with the yellow colouring matter of the safflower, or bastard saffron (*Carthamus tinctorius*), which grows in Egypt at the present day. This dye-stuff has been used from a very ancient period for dyeing silk in India, and has been tried in Europe for dyeing wool, but apparently not for linen or cotton. It is extremely fugitive when exposed to the action of light and air, and it is entirely owing to the fact that the yellow bandages on the mummies were thoroughly protected from these influences by the thick layers of bandages above them, that the colour had not faded. The brownish yellow pigment present in some of the bandages was identified as iron buff. Under the microscope the minute particles of iron oxide could be seen distributed over the surface of the fibres.

THE ACTION OF PAPER ON METALS.—It is not an uncommon thing for corrosion and oxidation of bright steel objects to be caused by the presence of injurious substances in the paper. This may be due either to free acids or chlorine compounds, or more frequently, especially in the case of hard-sized paper, to the excessive use of aluminium sulphate, which is gradually dissociated by atmospheric influences.

Another drawback associated with certain kinds of paper is the blackening (due to formation of sulphide) which it produces on articles of silver or copper. Owing to the growing use of paper of wood pulp prepared by digestion with sulphur compounds this blackening action is more prevalent now than formerly. In fact, it is asserted by Herr Klemm, in a recent investigation of this subject, that most, if not all, unbleached wood pulps of the sulphite and sulphate class contain traces of sulphur compounds that have a blackening action upon silver or copper; and that even bleached pulps may contain minute quantities of similar substances. Unbleached pulps prepared by the caustic soda process and mechanical wood pulps, however, are generally free from these sulphur compounds.

The active substances include sulphites, sulphides, and free sulphur. Sulphites may be detected by means of iodate paper and starch (acidified with acid), their presence being shown by a blue coloration caused by the liberated iodine. For the detection of sulphides, the paper is digested with a very dilute solution of caustic soda, the liquid acidified, and a strip of lead acetate paper suspended above it. In the presence of a sulphide, a brown coloration will be produced by the liberated hydrogen sulphide. Free sulphur may be identified by extracting the paper with chloroform, and evaporating the extract, the sulphur then being left in the form of characteristic crystals.

As a practical test of the corrosive action of a paper, Herr Klemm first prepares pieces of iron wire and watch spring by rubbing them with emery paper, after which they are only handled with forceps. These are pinned to strips of paper, which are folded over and placed under a bell-jar lined with moist filter-paper. A dish containing caustic potash is also introduced to absorb carbon dioxide, and a parallel test is made with pure filter paper at the same time. Under these conditions, if the pieces of steel do not show any signs of rusting after a week's exposure, the paper may be regarded as good.

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

THE PLEISTOCENE LAKE BONNEVILLE.—The Great Salt Lake of Utah is now recognised to be but a remnant of a far larger lake which formerly existed in early quaternary times. The shore-lines of this ancient lake are well marked, and show it to have occupied an area of more than 19,000 square miles, or about ten times the area of the present lake. Also, whereas the existing lake has a maximum depth of but 50 feet, its ancestor must at its maximum have been 1,000 feet deep. It is known to American geologists as Lake Bonneville. As the lake gradually dried up, it left smaller isolated lakes scattered about the lowest portions of its former bed. Deposits of salts were made as it dried up, chloride and sulphate of sodium being found in great quantities. Chamberlin and Salisbury estimate that the lake now contains 400 million tons of the former and 30 million tons of the latter. After Lake Bonneville had been brought first into existence and had lasted for some time, it appears to have disappeared, possibly through change of climate. When the lake was again restored it rose sufficiently high to find an outlet to the north, and the outflow cut its way downward to a depth of 375 feet. Distinct shore-lines were then developed, whilst precipitation continued to outbalance evaporation. After the lapse of a lengthy period a change of climate again brought about a reversal, and, evaporation exceeding precipitation, the shrinkage of the area of the lake gradually diminished it to its present dimensions, leaving smaller isolated lakes in various portions of the old basin.

LAKE LAHONTAN.—Further west, in Nevada, where are now the Mud Lakes, Lake Humboldt, and other small lakes, there was another large lake now known to geologists as Lake Lahontan, and this was probably co-existent with Lake Bonneville. Lake Lahontan is estimated to have covered an area of nearly 9,000 square miles. It seems to have passed through similar stages to those of Bonneville, and Professor Chamberlin suggests that high water in both lakes may have corresponded with epochs of glaciation in the mountainous regions around. In both cases volcanic eruptions occurred at different periods in the history of the lakes.

LAKE AGASSIZ.—Lake Winnipeg, again, is but the diminished representative of a great glacial lake which is known as Lake Agassiz. Dr. Warren Upham described the lake to the members of the British Association recently meeting at Winnipeg. Dr. Upham estimated its maximum area to have been about 110,000 square miles, an area

greater than that of the five great lakes of the St. Lawrence combined.

THE MOVING OF MOUNTAINS.—With regard to our remarks last month concerning Burrard and Hayden's work on the geology of the Himalayas and Tibet, we are reminded that geologists strongly suspect that these highland masses are gradually creeping southward, and are tending to further crumple up the Siwalik Hills at the expense of the great alluvial plain. At the meeting of the International Geodetic Association in September, Colonel Burrard described the measures which are being taken to discover what truth there is in the suggestion.

EARTH-TIDES.—In speaking of the earlier work of Sir George Darwin and Mr. Horace Darwin in regard to lunar earth-tides, *Nature* records the experiments of Professor Hecker at Potsdam in his endeavours to determine these tides. The results showed an undoubted periodicity in half a lunar day. The yielding is stated to be a little larger than would occur if the earth were a ball of steel, and about half the theoretical amount for a perfect fluid; there is little lag, so that the internal friction caused by deformation of the earth must be insignificant. An investigation as to whether the shape of the surface of the earth is changed by change of barometric pressure gave inconclusive results.

FREE LECTURES ON GEOLOGY AND EVOLUTION.—In connection with the University of London, a free course of advanced lectures on "Geology and Evolution" will be delivered by Professor J. W. Judd, F.R.S., in the Geological Department, Royal College of Science, South Kensington, at 5 p.m. on November 29, December 6 and 13. No tickets are required for the course.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

HIGHEST BALLOON ASCENT IN AMERICA.—Professor A. Lawrence Rotch, in a communication to *Science*, states that in May and July last year four "ballons-sondes" were sent up from Pittsfield, Mass., with special precautions to limit them from drifting out to sea with the upper westerly wind. Three of the registering instruments have been returned to the Blue Hill Observatory with good records. The first instrument sent up on May 7 was not found for ten months; the record, however, is very interesting because it gives a complete temperature record up to about 11 miles. This is 650 metres higher than the highest ascension from St. Louis. Professor Rotch says that "on May 7 a general storm prevailed, so that the balloon, travelling from the east, was soon lost in the cloud and its subsequent drift could not be followed, but the resultant course was 59 miles from the south-west, as determined by the place where the instrument fell two hours later. At the ground the temperature was 4°.5 C. (40°.1 F.), and this decreased as the balloon rose to the base of the cloud, which itself was considerably warmer than the underlying air. Above the cloud the temperature continued to fall with increasing rapidity up to a height of 12,500 metres (nearly 8 miles), where the minimum of −54°.5 C. (−66°. F.) was registered. Here the great warm stratum was entered and penetrated farther than ever before in America, namely, to the height of 17,700 metres (about 11 miles), where the temperature was −46°.5 C. (−51°.7 F.)."

RESULTS OF "BALLON-SONDE" OBSERVATIONS.—At the recent meeting of the British Association at Winnipeg, we learn from *Nature* that in Section A Professor W. J. Humphreys communicated some results which he had obtained from a consideration of European "ballons-sondes" observations, and that Mr. E. Gold presented the report on the present state of our knowledge of the upper air drawn up by Mr. Harwood and himself. One of the most interesting facts was that both Professor Humphreys and Mr. Gold found that in areas of high pressure (above 770mm. or 30.3 ins.), the temperature up to 9-10 kilometres was greater than in areas of low pressure (below 750mm., or 29.5 ins.), while at greater heights the conditions became reversed. So long as this condition holds and the isothermal or adjective regions exist, it appears impossible that there should be anything in the nature of circulatory interchange between cyclones and anti-cyclones, and the intensity of these systems cannot be maintained. Messrs. Gold and Harwood found remarkable minima in the height at which the adjective region begins in March and September, and an attempt was made to connect these minima with the general circulation of the atmosphere.

METEOROLOGICAL WORK IN INDIA.—From the "Report on the Administration of the Meteorological Department of the Government of India in 1908-9" we learn that 280 observatories contributed registers of meteorological data to the central office at Simla. Of these 50 were non-departmental, and 230 were maintained by the Government of India. The latter comprise 7 first-class, 21 second-class, 179 third-class, and 23 fourth-class stations. The registration of rainfall is carried out by the provincial authorities. The total number of rain gauges from which returns were furnished for publication during the year was 2,706. The information as to the amount, distribution, and time of occurrence of the snowfall in the Himalayan and Afghan mountain areas was on the whole tolerably complete. The difficulty has again been felt that while the reports may represent faithfully the impressions of subordinate officers, they cannot be relied upon for that accurate comparison of one year with another which is desirable in the interest of climatic study. Reliable additions to the information have been obtained by continuing, though from a lower altitude, the series of large-scale photographs of the snows as seen from Simla, which had been started in 1905. A number of "ballon-sonde" ascents with recording instruments were carried out during the year. Twenty-three instruments were sent up from Jhang, in the Punjab, two-thirds of them being recovered. The records show that the region of constant temperature is met with in India at heights of between 9 and 10 miles above the earth's surface, the temperature there ranging between −68° and −88° F.

KITE AND BALLOON STRUCK BY LIGHTNING.—The following telegraphic message from its Christiania correspondent appeared in the *Times* of July 24: "Captain Engelstad, of the Swedish Navy, who had been appointed second in command of Captain Roald Amundsen's forthcoming Polar expedition, was struck by lightning to-day (July 23) and killed. Captain Engelstad had been making practical experiments with kites flying at considerable altitudes, with a view to making aerial observations in the Arctic regions. While carrying on experiments to-day from an island in Christiania Fiord his kite, which had reached an altitude of 1,000 yards, was struck by lightning, which passed down the copper wire by which it was held, causing the instantaneous death of Captain Engelstad."

In connection with this it may be mentioned that at the meeting of the Royal Meteorological Society on May 15, 1907, Colonel J. E. Capper gave an account of a captive balloon being struck by lightning at Farnborough during a thunderstorm. The lightning flash appeared to travel along the wire until it reached the waggon; then a sudden bright light appeared and ran right up the wire into the clouds by which the balloon was hidden. The wire was fused, and burnt entirely away where it first touched the iron pulleys which guide the wire when running out. One side of the balloon and net was burnt, probably owing to the hydrogen catching fire.

ORNITHOLOGY.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

THE HABITS OF SKUAS.—Mr. A. M. C. Nicholl contributes to the *Field* (October 9) a most interesting article on the habits of the Great and Arctic Skuas, based on actual observations in the field during the month of August last.

Commenting on the variable character of the Arctic Skua in the matter of coloration, he remarks that there were three well-defined varieties, of which one had the breast so white that the birds so coloured might have been mistaken for gulls; further, these white-breasted birds had a "sooty-

black cap on the head." These, and a variety having a dark cervical patch dividing a white breast and chin, seemed to be on the increase, and Mr. Nicholl suggests that observations are kept on such birds during the breeding season with a view to discover whether they are preferred to their darker coloured brethren.

In feeding habits he notes an interesting difference between the Great and Arctic Skuas, for whereas the latter are inveterate gull-robbers, the Great Skuas never resort to such tactics, not so much, however, on account of their finer moral character, as because they lack the agility of the smaller Skuas when on the wing.

We are glad to note that owing to judicious protection the Great Skua is recovering in numbers.

HOOPOE IN YORKSHIRE.—In the *Field* (October 2), Mr. W. A. Durnford records the fact that on September 22 he had the good fortune to watch a Hoopoe for upwards of half-an-hour feeding on the worms brought to the surface by recent rain.

ALPINE SWIFT IN NORFOLK.—Mr. D. W. Mussel-White, in *British Birds* for October, records the fact that during the month of July he had many opportunities of watching an Alpine Swift at Cromer. The striking appearance of this bird when on the wing leaves no room for doubt as to its identity.

WHITE-WINGED BLACK TERN IN WARWICKSHIRE.—A specimen of the White-Winged Black Tern, accompanied by a Black Tern, was kept under observation at Packington, on May 8, by Mr. A. G. Leigh, who records the fact in *British Birds* for October.

A PIED JACK SNIPE.—Variations of colour in this species are sufficiently uncommon to be worth recording. In the *Field* (October 9), there will be found an excellent photograph of a Jack Snipe, wherein the primaries, outer secondaries, and their coverts are pure white. This bird, recently killed near Sutton, Surrey, has now been added to the fine collection of pied and white varieties of birds which has been formed by Mr. J. Whitaker, of Rainworth Lodge, near Mansfield.

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

ON THE ABSORPTION OF BETA-RAYS.—It has usually been assumed that, when beta-rays are absorbed according to an exponential law, the beam of rays must be a homogeneous one. This assumption is based upon the behaviour of a homogeneous beam of light in passing through an absorbing medium. Mr. W. Wilson, in a recent paper (Royal Society *Proceedings*, A Vol. 82, 1909), puts forward some experimental results which seem to be in conflict with this assumption. Separating a beam of beta-rays from radium by means of the deflecting action of a magnetic field into bundles, each of which is, at least approximately, homogeneous, he finds that instead of the expected exponential law the absorption increases with the thickness of the material at a faster rate than this law would give. In some cases, especially for rays of high velocity, the curve obtained by plotting the ionisation which the emergent rays are capable of producing against the thickness of the material through which they have passed is practically a straight line. It would thus appear that in those cases for which an exponential curve has been obtained by different observers the result is to be explained as due to the particular nature of the heterogeneity of the rays employed, and is no criterion of their homogeneity as hitherto supposed. He shows theoretically that it is quite possible for a simple exponential law of absorption to be the resultant effect of the absorption of rays, each absorbed according to a linear law, and initially present in certain fixed proportions. This theory would therefore imply that the rays from radium are in reality highly complex.

This conclusion should be compared with a working hypothesis which Dr. O. Hahn has recently taken as a basis for deciding whether a radioactive element is pure or not. The hypothesis is that a pure substance gives out only one type of homogeneous rays, either all alpha or all beta. He concludes that radium consists of two pure substances: radium, which gives out homogeneous beta-rays, and radium X, which gives out the well-known alpha rays. It is not easy to reconcile the consequences of applying this working-hypothesis with the results of the experiment and theory of Mr. W. Wilson.

THE RATE OF RE-COMBINATION OF IONS.—The rate at which ions re-combine was found by McClung to increase with increasing temperature. Langevin, however, showed that the experimental results on which this conclusion was based were affected with error, owing to diffusion of the ions. Dr. P. Phillips has recently determined this rate at various temperatures, for ions produced by Röntgen rays, devising his experiment so as to avoid this source of error. He finds instead a very marked decrease. The values at various temperatures are quoted in the following table:—

Temperature.	α	Erikson.
15°C.	1.00	1.00
100	.50	.51
155	.40	.405
178	.36	.38 (extrapolated).

Alongside these values are placed values for the rate of re-combination of ions produced by radium; these were obtained recently by Professor Erikson. The methods used in the two series of experiments were very different. It is very satisfactory, therefore, to find the two sets of numbers so completely in agreement. It leaves no room for doubt of the accuracy of both sets.

ZOOLOGY.

By R. LYDEKKER.

THE BLUE HARE AND ITS NAMES.—I have been told that were it not for my own obstructiveness the happy millennium as regards the scientific nomenclature of mammals would long ago have been reached, and that we should all be using the same names; but this does not appear to be borne out in one of the instances where, against my own inclinations, I have followed the new fashion. The case in question is that of the blue hare, for which species I have adopted the name *Lepus timidus*, long applied to the English brown hare, although originally given by Linnæus to the blue hare of Sweden. In place of this leading to uniformity of nomenclature I find that Mr. M. A. C. Hinton, in a paper on a fossil hare from Kent, published in the *Scientific Proceedings* of the Royal Dublin Society, expresses himself as follows:—

"I prefer to follow the lead of Winge and Newton by retaining the name of *L. variabilis*, Pallas, for the snow or varying [=blue] hare. The use of the name *L. timidus*, Linné, for this species, after its long if erroneous application to *L. europæus*, Pallas, can only serve to confuse matters. It would, indeed, be well if the systematists could be induced to realise that science is concerned with things rather than with their names, and that the 'balance of convenience' is as worthy of consideration in natural as it is in legal science."

My sympathies in the matter are entirely with Mr. Hinton, although, having once made the change to *timidus*, I hesitate to go back. But no more changes of names for me, especially as, as I have more than insisted, it involves remembering two names in place of one.

In the course of his paper Mr. Hinton points out that the blue hare was the original British representative of the group, and that it appears to have been driven out of England by the arrival of the brown species; whereas, in Ireland, where the latter never obtained an entrance, it has survived to the present day. Further, the fossil English blue hare (*L. v. anglicus*) and its living Irish cousin appear to be less specialised forms of the species, as indicated by their relatively shorter limbs, than the northern races; whence it is argued that the original home of the blue hare was probably in Central Asia.

THE COLOURING OF BONTE-QUAGGAS.—In the August issue of the Zoological Society's *Proceedings*, Mr. R. I. Pocock has pointed out an interesting peculiarity in the colouring

of the more northern races of the bonte-quagga, or Burchell's zebra. This is the sharp division of the body into two distinct areas by the direction of the stripes; those of the front half being more or less nearly vertical, while those in the hind portion tend to be horizontal. The optical effect of this is to divide the animal into two distinct objects, when viewed at a certain distance, so that the outline of an entire horse is more or less obscured. The effect is enhanced by the stripes at the base of the neck, which are broader than, and inclined at an angle to, those of the shoulder when the head is in the usual pose. Nor is this all, for the stripes of the head are narrower than those on the neck and also somewhat different in direction; while on the legs the stripes, if present at all, are horizontal. Apart from the legs, a bonte-quagga is thus broken up by the nature and direction of the stripes into four separate areas, namely, the head, the neck, and the front and hind halves of the trunk. At a distance less then than that at which the whole of the stripes merge into a grey blur, the general effect is to render the animal much less conspicuous than were it coloured in the same manner from head to tail and from back to hoof. It is probable that much the same effect is produced by the division of the body of the Malay tapir into a dark front and a light hind portion.

A NEW RATEL.—In the same issue, Mr. Pocock also describes a new species of ratel, or honey-badger (*Mellevora signata*), which is of interest from three points of view. In the first place, it came from Sierra Leone, and thereby adds considerably to the previously known range of the genus. Secondly, it differs from other ratels by the completely white crown of the head; while, in the third place, its diet is reported to differ considerably from that attributed to other species. For according to native testimony, this ratel, which is nocturnal in its habits, like the rest of its kind, subsists largely upon fish, captured with its paws in shallow water. Support to this statement is afforded by the fact that while in captivity the type specimen showed a marked preference for fish, as compared with flesh. It also liked bread better than meat. When kept in the poultry-yard, it showed no inclination to molest the fowls; but when placed with a litter of puppies, it promptly devoured the lot.

THE SLIPPER-LIMPET.—It has been pointed out to me that in a recent issue of "KNOWLEDGE" I have referred to the slipper-limpet (*Crepidula fornicata*) as a well-known British species. This is scarcely correct, for although the species occurs in the estuary of the Crouch, it was introduced there adhering to American oysters.

REVIEWS OF BOOKS.

CHEMISTRY.

The Fundamental Principles of Chemistry, by W. Ostwald. Translated by H. W. Morse (London: Longmans; pp. xii. and 349; 7s. 6d. net).—Generalisation is the keynote of this valuable book, and its scope is fairly indicated in its sub-title, "An Introduction to all Text-Books in Chemistry." It is an attempt to weave the principles of chemistry into a coherent scientific fabric, without bringing in the properties of individual chemical substances. Some practical knowledge of the isolated facts of chemistry seems necessary, however, before the student will be able to follow with much advantage Professor Ostwald's admirable summaries of the principles underlying them. In fact, as is pointed out in the preface, the book is designed not only for the student, but also for the teacher, to whom it is intended to be a guide in the methods of generalisation. The ground covered in the book may be indicated by mentioning that it includes chapters upon the states of matter, the nature of solution, elements and compounds, the velocity of reaction, isomerism, and the ions. As is the case with all Professor Ostwald's works, the argument is easy to follow, and it may be added that this quality has not suffered in the work of translation, which has been excellently done.

MICROSCOPY.

Elementary Photo-Micrography, by Walter Bagshaw. Second edition (London: Iliffe and Sons, Ltd., 1909; pp. 103, 45 illustrations, crown 8vo, cloth; 2s. 6d. net).—The present reviewer, not having seen the first edition of this book, is unable to say how far this edition differs from the first, published seven years ago. The book makes no claim to be a complete exposition of the subject, but is written for beginners, and is intended to show them how to produce good photographs with simple and inexpensive apparatus, namely, an ordinary microscope lamp and condenser, a tube carrying objective and eyepiece, and an ordinary short photographic camera, the whole mounted on a simple form of base-board, or an adaptation of these for use with an ordinary microscope. The instructions given are clear and easy to follow, and do not confuse the beginner with too much detail, whilst development of the plate and printing of the negative are dealt with as fully as can be expected in a book of this size. The photo-micrographs illustrating the book reflect credit upon the author, if taken entirely with the simple apparatus described. Bearing in mind the admittedly modest scope of the book, it would be unfair to call attention to omissions or insufficient directions, but one cannot help wondering why in the list of useful books at the end Pringle and Bousfield's well-known and most practical books on photo-micrography are apparently deliberately omitted.

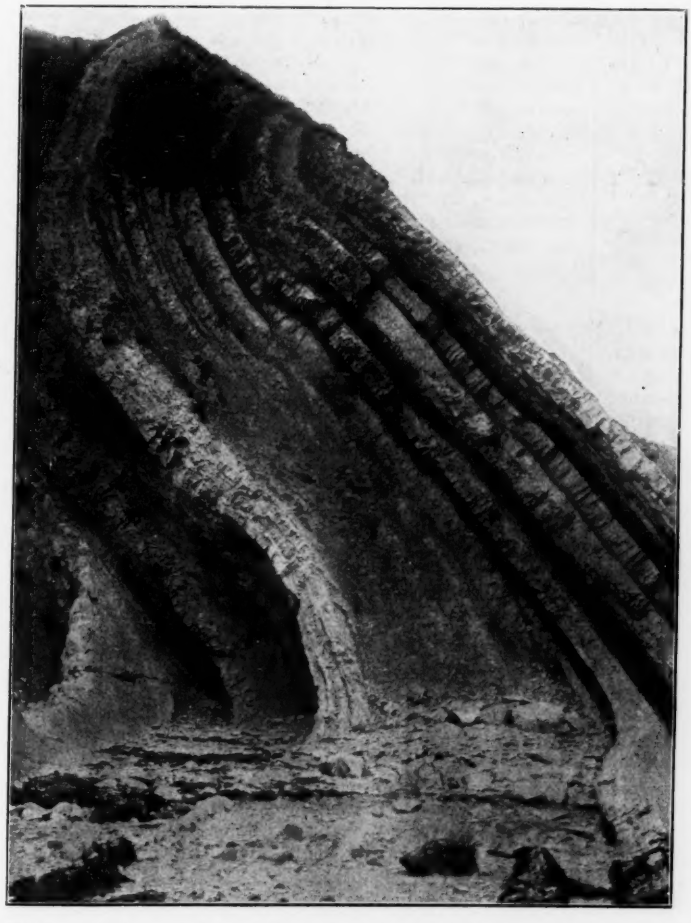
NATURAL HISTORY.

The Wood I Know; The Common I Know; The Stream I Know; The Pond I Know; The Meadow I Know, by W. Percival Westall, F.L.S., and Henry E. Turner.—These are five books in Dent's Open-Air Nature Books, each consisting of about 75 pages, and are published at 1s. net. Each contains a dozen or more coloured plates or half-tones, and numerous outline illustrations. The writer has in these little books found something approaching his ideal of what nature-study books should be. They describe in simple language the familiar objects of certain habitats, as shown by the titles, and they do not contain descriptions of a lot of things which are not familiar and which only appeal to those who have decided to search for unfamiliar objects. Things seen often by the country-side are always interesting, and ripening of acquaintance with familiarities will lead to a desire for acquaintance with things not often seen, which have to be sought for. Mr. Turner is General Secretary of the School Nature-Study Union, and it would seem from these books that he knows exactly what schools need. Enough to attract, without enough to repel, might be the motto of these excellent little books.

A Guide to the Natural History of the Isle of Wight, by Frank Morey, F.L.S. (The County Press, Newport, and William Wesley and Son, 28, Essex Street, London, W.C.; 550 pp., demy 8vo, illustrated, with map of the island; 8s. 6d. net).—In his introduction, the editor shows how he came to undertake the great task, the accomplishment of which is now before us. The magnitude of the volume is to some extent a guide to the magnitude of the task. The island contains 145 square miles, and information is given concerning nearly 7,000 species of local animals and plants, besides which there are chapters on geology, earthquakes, stone implements, and meteorology. The work is likely to be the standard work for many years to come, although such is the detail in which certain sections have been carried out that no one naturalist is likely to be equally interested in all. We have one grumble to make. Geology is dealt with by Mr. G. W. Colenutt, F.G.S., in 34 pages, accompanied by excellent diagrams, but, as is customary, no fossil lists are given. Insects occupy 82 pages, and detailed lists are given. Similarly, there are lists of fungi, algæ, lichens, plants, infusoria, mollusca, crustacea, etc., and these will be of immense value. The island is a valuable training-ground for geologists, and it is a great pity lists of fossils are not found in the book. It is a defect frequently found in other books of general natural history, but it is none the less a defect, and it seems to show that geology has not yet taken its proper place in general nature-subjects.

MISCELLANEOUS.

A Study of the Principles of Nature, by Frederick Hovenden, F.L.S., F.G.S. (London: Chapman and Hall; pp. 147, demy 8vo, illustrated; 6s.).—This work contains four lectures delivered by the author at the London Institution in the capacity of vice-president. The first lecture might well be entitled, as suggested by the author, "Nature's Masonry and Nature's Ruins." In 62 pages he gives a clear and interesting exposition of the geology of the Isle of Purbeck. The district is one of the most fascinating to the geologist, and without in any way being written in guide-book style is a safe and sure guide to anyone visiting the coast-line thereabouts and wishing to know the structure of the district visited. But it is not a mere catalogue of rocks. Philosophy is blended with facts in the true spirit of nature-study, and one who has not visited



Purbeck will on reading the lecture not rest satisfied until he has seen with his own eyes all the interesting points noted in the text. Mr. Hovenden's style reminds one of the great Dr. Mantell's, and those who have been geologically fed in their early days by the Doctor's works will recognise the same love of communion with geological nature in the field. The illustrations are excellent, and are for the most part reproduced from photographs. We are enabled to give one of the most striking of these, showing the vertical and contorted beds at the west entrance to Lulworth Cove, which had been originally deposited in water in a horizontal manner. The three other lectures given in the book are of a very different nature, although, in a sense, they have a bearing on geological processes. A number of interesting experiments are quoted, all tending to demonstrate the existence of "ether atoms," or, as generally called, "electrons" or "corpuscles," and their all-importance in the birth and death of Nature. "There is a fluid," the author concludes, "which is under ordinary conditions invisible to the naked eye, and which permeates everything. This fluid is in differential motion; this motion, acting upon those very minute objects called molecules, causes them to assume the solid, liquid, gaseous, and incandescent forms." "Low temperature means molecules almost entirely devoid of ether." It is contended that liquid air is merely air reduced in volume by the abstraction of its ether, each molecule of air being reduced in volume. The greater or less flow of ether is responsible for the many things which we have been accustomed to regard as resulting from accession or loss of heat. The book is full of suggestion. The author is a pioneer, and as such he naturally falls foul of some of our science experts, from whom he apparently does not always receive that attention which he manifestly considers is his due.

An Atlas of Absorption Spectra, by C. E. Kenneth Mees, D.Sc. (London: Longmans, Green and Co. Croydon: Wratten and Wainwright, Ltd., 1909; 74 pp.; price 6s.).—The necessity for regulating the colour of the light employed in photographic operations, as, for example, in "orthochromatic" work, in telephotography, and in photomicrography, renders every new dye of interest, and a considerable number of more or less permanent value. The most convenient way of cataloguing dyes for such purposes is by means of their absorption spectra. Messrs. Uhler and Wood a few years ago prepared an atlas of dye spectra with the greatest care, but they used "Seed" orthochromatic plates for their photographs and so neglected the red. Dr. Mees' photographs are made on panchromatic plates which are sensitive to beyond B, and therefore include all the visible red, and sometimes go much further. We notice in the new atlas many dyes that are not given in the other, especially greens, which even still leave something to be desired. There are one hundred and seventy absorption spectra of, perhaps, nearly a hundred dyes, with a statement as to the commercial source and stability to light of each, and also whether it is acidic or basic. After this follow the spectra of seventy-six filters or colour screens that can be obtained from Messrs. Wratten and Wainwright. We welcome the volume as a most useful contribution to the subject with which it deals.

Webster's Dictionary.—The new edition of Webster's Dictionary which is being published by George Bell and Sons is an indispensable addition to the library of the student and the scholar. On the sound foundation of the original work additions have been built up which embrace the new words added to the language by Science and Technology, as well as the foreign words brought into the language by the closer relations of the English-speaking peoples with other races. Thus in the first of these classes are words such as Radium, Coherer, Electron, or Aerodrome; while such additions to the common tongue as Marconigram or Bertillon (in allusion to M. Bertillon's anthropometric system) are defined and explained. In the second class are Tamale, Kopje, Trek, Paprika, or Tabasco; and in addition to these "Webster" embraces dialect and slang words whose usage in magazine or novel warrants their sparing admission into a dictionary of the established language. Such words are Bash or Faker, Jamboree or Frazzle. Many of these words have been inserted from time to time by changes in the plates; and 25,000 more are now added in a 234-page Supplement. Special attention has been paid to advances in Botany and Zoology; and in the Supplement, as in the main body of the Dictionary, the etymological derivation has received most careful attention.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, M.A., F.R.M.S.

Economical Monochromatic Filters.

A FRENCH writer, M. J. Jullien, has given an economical method by which filtering screens for obtaining monochromatic light for photographic or visual purposes can be easily obtained. An unexposed photographic plate is taken, fixed by means of hypo-sulphite of soda, and washed as if it were a negative. It is then immersed for some minutes in the following solution:

Alcohol, 70 per cent. ...	... 200 cc.
Mars yellow (aniline) ...	... 1 gr.

The stained plate is then dried, protected from dust, and will give a filter very nearly approaching the ideal yellow. Other aniline colours may be used to make other screens, such as green, after comparative examination by means of a spectroscope, and will be found to give good results.

The same writer describes a home-made camera for photo-micrography, at the cost of a couple of shillings, by fitting up a light-tight box on trestles, piercing the bottom for the insertion of the microscope tube, and fitting a plate of ground-glass to the top. The light used is the ordinary incandescent gas lamp.

Kinematography of Fertilisation and Cell-division.

The kinematograph has been applied to many scientific purposes, one of the most recent of which has been the exhibition of a series of films representing in a very life-like manner the various bizarre, but distinctive, gaits and other movements in certain nervous diseases. A German investigator, J. Ries, has recently described his application of a kinematograph for the photography of the successive changes occurring during fertilisation and cell-division. The microscope was used in the upright position, the photographic apparatus in the horizontal position, and a prism was inserted between the eye-piece and the bellows of the camera. The kinematograph was an ordinary Lumière apparatus, actuated by a clockwork mechanism which turned the crank seven times a minute. A mirror, which rotated 45°, was inserted in a box between the camera bellows and the kinematograph so as to throw the image on a round glass disc. The process of division could thus be controlled by watching it on the glass disc, and when the egg was ripe for division the mirror was turned and the rays were then directed upon the film in the kinematograph. The focus of the glass disc and of the film, of course, corresponded. The author at first used an electric lamp of the ordinary filament type, but found this, as might be expected, unsatisfactory, and finally made use of sunlight and light from an arc lamp.

Illuminating Opaque Objects.

There are two ways of illuminating microscopic objects—by light passed through them, and by light reflected from their surfaces. To pass light through objects it is manifestly necessary that they should be transparent, and for this purpose our present elaborate methods of killing and fixing, hardening, clearing, embedding, sectioning, staining, and mounting in Canada balsam and other media have been devised. But opaque objects require in most cases only the most elementary mounting, and are then illuminated by light reflected from their surfaces, and the methods available for obtaining such illumination in a satisfactory manner are the subject of the present note, as they offer unexpected difficulties to many workers who are not familiar with microscopic appliances and accessories.

Even with a low power—say a 2-inch—the mere illumination of the object upon the stage with daylight or artificial light is quickly seen to be insufficient, and the general procedure is to use an ordinary uncorrected bull's-eye of about an inch and a half diameter and upwards in order to bring a shaft of light down upon the object. Here, again, ordinary diffused daylight gives insufficient illumination, as there is nothing to focus, and light from a lamp, whether of oil, gas, or electricity, is made use of. To obtain the best results by such means it is necessary to place the source of illumination well above the stage and about a foot or less away, to turn the plane side of the bull's-eye towards the object, and to focus the rays of light upon the latter, remembering that the focus is short, and not omitting to observe that the bull's-eye is in the centre of a line drawn from the lamp to the object and at right

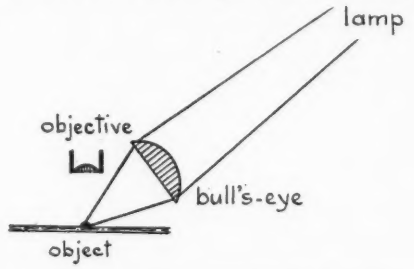


Fig. 1.—Method of illuminating opaque objects by means of a bull's-eye condenser.

angles to it. Fig. 1 represents the position in a diagrammatic way.

The drawback to the method of illumination just mentioned is that the light is very much to one side, as the objective gets in the way if the light and bull's-eye are adjusted to give more perpendicular illumination, and especially so with short focus objectives. As a result the object is brightly lit upon one side, and there are dark and heavy shadows upon the other side. For ordinary visual work this is a serious, and for photo-micrography a fatal, objection.

The next method is by means of what is known as a side-silver reflector. This is a segment of a parabolic silvered mirror. In most opticians' catalogues this is offered for sale to attach to the stage limb, or body tube, but a much more convenient way is to have it mounted upon an ordinary stand such as is supplied with the bull's-eye above mentioned. The focus of the reflector is short, and it requires a little adjustment to give the best results, but once one gets into the way of using it the adjustments are seen to be simple enough, and the results are a great advance upon the method previously mentioned. The accompanying diagram (Fig. 2) will make things clear. The lamp is placed just above the level of the stage so as to send light horizontally across it. If the lamp is fitted with a bull's-eye, so much the better, if not an ordinary bull's-eye on a stand, as mentioned above, may be used, with

the same care in adjustment to keep the bull's-eye in the centre of and at right angles to a line drawn from the light to (in this case) the centre of the reflector, but the light required by the reflector is parallel light, or very slightly divergent light, and to obtain this the bull's-eye must have its plane side turned against the source of illumination (this being the position of least spherical aberration) and fairly close to it. In all these adjustments a little focussing upon a sheet of white paper held in the required positions is a useful aid until one gets used to the conditions. It will be noted that the reflector is quite close to the object, with its lower edge near the stage and the upper edge near the objective, and leaning well forward to focus the light

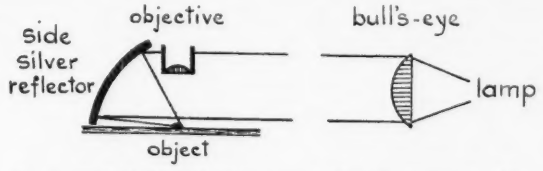


Fig. 2.—Method of illuminating opaque objects by means of a side-silver reflector and bull's-eye condenser.

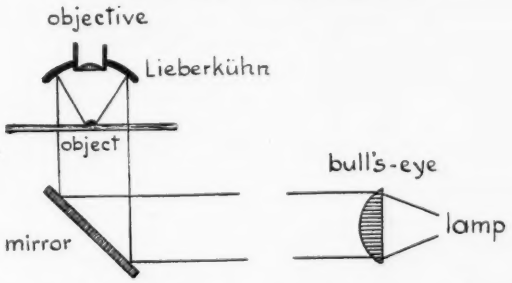


Fig 3—Method of illuminating opaque objects by means of a Lieberkuhn.

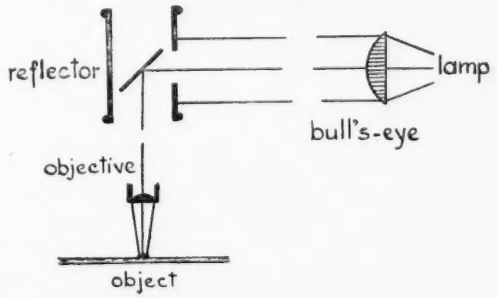


Fig. 4.—Method of illuminating opaque objects by means of a vertical illuminator and bull's-eye condenser.

downwards upon the object. The use of the side-silver reflector gives the best results of any apparatus for general work, though even here the lighting is, of course, somewhat one-sided and the shadow heavier on one side.

The third method of illuminating opaque objects is by the now but little seen Lieberkühn. This is a speculum of definite size and focus which screws in above the objective and embraces it like a wide collar, the focus of the speculum, and, therefore, of the light reflected from it, coinciding with the focus of the objective. The drawbacks to the use of the Lieberkühner, which have caused its disuse, are manifest, namely, that a separate speculum is required for each objective, and that as the light comes from below, objects must be specially mounted to allow light to pass round them, as illustrated in Fig. 3. For the ordinary opaque object mounted in a cell with a disc of black paper or varnish round it this is impossible, but the Lieberkühn gives the best results of all when used properly, giving a uniform top light upon all sides of the object, and it deserves, therefore, more wide recognition. Most opaque objects can be mounted in a dry cell without any background for use with a Lieberkühn, and when used with other methods of opaque illumination a black disc of paper or varnish placed upon another slide can be placed under them, though, of course, there will be a certain amount of reflection from the glass surfaces of the first slide.

There remains yet another method of illuminating opaque objects, and this is by means of what is known as a "vertical illuminator." Its use is almost entirely confined to high power and immersion lenses, and, indeed, it is the only means we have at our disposal for illuminating opaque objects with such powers, and it is much used in this way for examining sections of metals. In its simplest form it consists of a circular cover-glass mounted on a rotating pin in a ring which screws above the objective. The principle will be evident from Fig. 4, when it will be seen that the light, preferably made parallel or slightly divergent by a bull's-eye in the way already detailed, is set about eight inches away from, and exactly level with, and opposite to, the opening in the nose-piece containing the reflector, and that the reflector, being set at an angle of 45°, reflects the rays of light at right angles down the tube and through the objective on to the object, without interfering appreciably with the image received through the same objective and the eyepiece. In fact, the objective acts as its own inverted high-power achromatic condenser! A modified form of this piece of apparatus consists in the substitution of a prism, cutting off half the field of view, for the cover-glass reflector, and various forms of diaphragm are added to facilitate adjustment of the light, the more elaborate forms having an iris diaphragm in the aperture for illumination. Leitz provides a small lens to ensure a strong and accurately focussed light, and an arrangement by means of which the light is more conveniently reflected into the apparatus.

With ordinary high-power dry lenses the object—say a piece of polished metal—is examined uncovered, and as objectives are corrected by the makers to work through a cover-glass, and, moreover, a cover-glass of definite thickness, it follows that such a lens will not perform at its best when used with uncovered objects, and, therefore, strictly speaking, the objective used should be one corrected for use without cover-glass. With immersion lenses this matter is of much less importance, but the object should be in actual contact with the cover-glass when one is used. For really critical work, however, another consideration comes in. The objective, when focussed upon the object, brings the rays into focus at a point somewhere about the diaphragm of the eye-piece, which lies nearly midway between the field-lens and eye-lens of the latter, this point varying with any change of eyepiece. The reason for this is, of course, that the field lens acts in a sense as part of the objective, collecting the rays and bringing them to a focus in a position where they can be subsequently magnified by the eye-lens. But as we have explained that the objective is performing a dual function and acting as its own condenser, it follows that the rays of illumination must also be focussed upon the object, and this can only happen if the position of the light corresponds in distance to that of the eye-piece diaphragm. This can be arrived at by measuring

the distance between the cover-glass of the reflector and the diaphragm of the ocular, and placing the source of illumination at the same distance from the former. When a bull's-eye is interposed a further slight modification becomes necessary, and the bull's-eye must be adjusted for slightly divergent rather than for parallel light.

Of course, once these adjustments are made it is important that they should not be disturbed, any movement of the microscope tube, as in focussing, putting the aperture opposite to the reflector out of line with the axis of illumination, and to obviate this metallurgical microscopes are constructed with a stage which moves to focus the object rather than the body-tube.

It is advisable also to have the reflector as close to the back of the objective as possible, and, therefore, objectives with short mounts are advantageous.

There remains to be mentioned the difficulty of obtaining efficient illumination of opaque objects for photomicrographic purposes, a strong light being necessary if exposures are not to be inconveniently prolonged, whilst illumination from one side only is manifestly inadmissible. The side-silver reflector gives fair results, but the best results are obtained by the use of two sources of illumination, say a side-silver reflector and a bull's-eye focussed independently, or two independent bull's-eyes. The Lieberkühn is a good means of illuminating opaque objects uniformly for photo-micrographic purposes, but it has already been pointed out that it is necessary for the object to be so mounted as to allow the light to pass around it from beneath.

(I am indebted to Messrs. Baillière, Tindall, and Cox for the loan of the four figures illustrating this note, which are taken from the new edition of the author's "Practical Microscopy.")

Embedding Small Objects.

Most workers have been troubled at some time with the difficulty of embedding in paraffin very minute objects which, by reason of their small size, are apt to be widely scattered in the embedding medium, and even when retained in some kind of an envelope the process is troublesome and inconvenient in many ways. I have been much helped in this respect by a simple procedure which was originally described by G. Lefevre in the Journal of Applied Microscopy (now discontinued), and which, I think, is worth repeating here. The method was originally used for Echinoderm eggs, but is useful for embedding any other minute objects.

The accompanying illustrations will make the procedure clear. A flat, solid watch-glass is obtained, and in this is cut a narrow slot-like groove or trough, as represented in Figs. 1, 2, and 3. The groove may be about half an inch long by one-eighth inch wide and one-eighth deep. The watch-glass is warmed ready for the reception of the paraffin, as it is of importance that the latter should not solidify until it is desired to do so. If an embedding bath is at hand the watch-glass can be kept on this, but otherwise a hot plate must be used, preferably a long, narrow strip of copper with a flame under one end, and this will naturally require adjustment to the right temperature, and watching afterwards. When the objects are ready to be embedded the dish is filled with melted paraffin and the objects are carefully dropped into the groove, where they will naturally remain close together. A pipette may frequently be used with advantage. The dish is then rapidly cooled on the surface of water in the usual way, and when the paraffin is thoroughly hardened it may be removed without any difficulty, when the paraffin which filled the groove, and which, of course, contains the objects, will project from the surface of the block as shown in Fig. 4. It can then be trimmed into a suitable shape for fastening to the object-holder of the microtome, or for the clamp.

Attention to several little details will, as pointed out by the author, facilitate the process. The objects may, with advantage, be dehydrated in round-bottomed tubes, the change of liquids being made entirely by means of pipettes. After saturation with the solvent, the tube is placed on the paraffin-bath and melted paraffin added with a *warm* pipette. When ready for embedding, the objects are drawn into a pipette and carefully dropped into the groove of the watch-glass containing melted paraffin. It is advisable to rub a very thin film of *dilute* glycerine on the inside of the dish and on the sides and bottom of the groove to prevent any tendency of the paraffin to stick to the glass. Objects may be

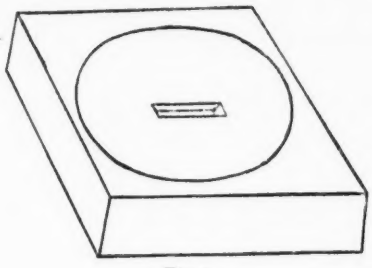


Fig. 1.

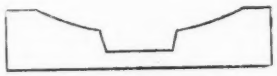


Fig. 2.

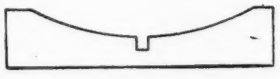


Fig. 3.

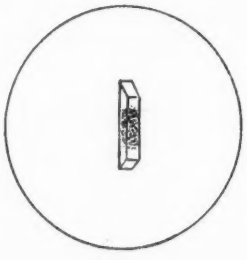


Fig. 4.

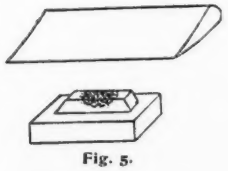


Fig. 5.

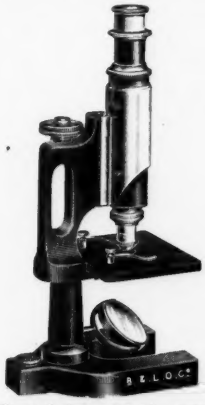
pushed into the groove or to one end of it by means of a needle. Mr. Lefevre finds it even possible to dispense with the round-bottom tubes and to perform the whole process in the embedding dish by keeping the objects in the groove and making the change of liquids with a pipette. The dish must be cooled rapidly on the surface of water or the paraffin will not crystallise properly and will, therefore, not cut well, and no attempt must be made to remove it until it is thoroughly hardened, and the knife is then inserted under the paraffin *opposite one end of the groove*, and the whole mass lifted up. The edges of the strip of paraffin containing the objects being parallel do not require trimming, and the cut may be made parallel with either the long or short sides.

The grooved dish is useful also for the orientating of other small objects.

Bausch and Lomb Improved Microscopes.

The type of microscope known as the Continental model has undergone considerable improvements of late, and it is noteworthy that the hitherto almost

universal form of direct-acting micrometer-screw fine adjustment, carrying the whole limb and body-tube, has gradually given place to the much more reliable and sensitive English lever form with rigid limb, a notable admission that English workers who called attention to the imperfections of the Continental model in this respect were justified in their criticisms. The Bausch and Lomb Optical Co., of Rochester, N.Y., who have always closely followed Continental practice in their instruments, are not behind-hand in adopting the improvements mentioned above, and have modified their microscopes to bring them in line with the most recent practice. Their most recent list, mentioned in another column, contains microscopes fitted with a sensitive



Bausch & Lomb's Stand AH.

Bausch & Lomb's Stand BH.

lever fine adjustment working in a limb of the well-known Jackson type, but which has been modified so as to form a convenient and attractive-looking handle for carrying. These microscopes are uniform in pattern, and the less expensive stands can, therefore, easily be built up into more elaborate forms by subsequent additions when more advanced work calls for it or the purse permits of it. The stand known as the "BH," and illustrated herewith, represents the usual students' type, and is fitted with swing-out and screw-focussing sub-stage, independent stage diaphragm for use without the condenser, ebonite stage, and draw-tube, and a more elaborate sub-stage and removable mechanical stage can be supplied. The same microscope (Stand AH) is supplied with non-inclinable body, sliding-coarse adjustment, and without sub-stage.

Dr. Henri van Heurck.

The death of Dr. Henri van Heurck, which took place at Antwerp on March 13 last, deprived Belgium of one of its best-known scientific men, the world of one of its leading authorities on diatoms, and microscopists of a man who had done much to advance microscopy. I am indebted to an obituary notice which appears in the current issue of the Royal Microscopical Society's Journal for the following particulars of his career, which will, I think, prove of interest to many who may not see the original account.

Dr. Henri van Heurck was born at Antwerp on August 28, 1838, and was thus in his 71st year when he died. He began his scientific career by writing papers on floristic and medical subjects, but soon became attracted by microscopy in general and diatoms in particular, quickly taking rank amongst the most distinguished authors in these branches of science.

His handbook, "Le Microscope," first published in Paris in 1865, and passing through new editions in 1868, 1878, and 1891, has been made known to many English readers through the excellent translation of Mr. Wynne E. Baxter, F.L.S., the present Treasurer of the Royal Microscopical Society.

Of his other contributions to general microscopy mention must be made of a paper on apochromatic objectives, with especial reference to a comparison between the 2 mm. and 3 mm. modern apochromats, and of a paper on Media of High Refractive Index, including Canada balsam, styrax, liquidambar, naphthalin monobromide, methyl iodide, and Smith's arsenical medium (realgar dissolved in bromide of arsenic).

Dr. van Heurck's profound knowledge of the theory and practical use of the microscope enabled him to attack not a few problems connected with the diatomaceæ, and in various papers he discussed the structure of the valves, and above all the nature of the striæ, following the Abbé Castracane in making great use of photomicrography. In this respect he made a special study of *Amphipleura pellucida*, determining exactly the number of striæ, which differed by little from the number already determined by Castracane.

By patient accumulation of observations, and the use of a rich collection of slides, Dr. van Heurck arrived at a profound knowledge of the siliceous algæ, and with the aid of his friend, Albert Grunow, facilitated, with Mr. F. Kitton, the editing of the well-known "Synopsis des Diatomées de Belgique," a work indispensable to diatomists.

When the Synopsis became out of print Dr. van Heurck planned a work more accessible to general diatomists, which should give descriptions and figures of all the species found in the North Sea and the countries surrounding it, and in 1896, therefore, was published in English, under the editorship of Mr. Wynne E. Baxter, the "Treatise on the Diatomaceæ." Mr. Baxter, himself a skilled diatomist, not only undertook the translation of the text, but also the cost of printing the English edition. The French edition was not published until 1899.

This great treatise, with its 35 plates and numerous figures in the text, gives valuable information on the morphology and biology of diatoms, on methods of collecting, studying, and preparing the material, and contains a section devoted to descriptive and systematic work, following in the main the classification proposed by Hamilton L. Smith in 1872.

Of other work to which Dr. van Heurck devoted himself, I have, unfortunately, not space to speak. He was Professor of Botany and Director of the Botanic Garden at Antwerp, and received public recognition from both Government and scientific societies, not the least tribute to his eminence as a microscopist being his election in 1883 to an Honorary Fellowship in the Royal Microscopical Society. Of the esteem in which he was held privately the many affecting references published by his friends at his death bear witness.

Notes and Queries.

Dark-Ground Illumination.—In connection with my remarks under this heading in the October issue of "KNOWLEDGE," concerning Leitz's form of paraboloidal condenser, Messrs. Leitz inform me that though they have improved the construction of their condenser they have adhered to the form illustrated in Fig. 5, page 397. The stage-plate form made by the same makers is identical in construction and size, though differing in the mounting. Its less satisfactory performance in the writer's hands was probably due to its being more difficult to centre.

[Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Redcourt," Adams Road, Cambridge. Correspondents are requested not to send specimens to be named.]

The Face of the Sky for November.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.54 and sets at 4.32; on the 30th he rises at 7.43 and sets at 3.53. Sunspots and faculæ have lately been very conspicuous. The equation of time is a maximum on the 3rd, the Sun being 16m. 21s. in advance of the clock, thus making the afternoons short and the mornings long. The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Nov. 2 ..	24° 28′E	4° 10′	142° 44′
,, 7 ..	23° 29′E	3° 37′	76° 49′
,, 12 ..	22° 19′E	3° 4′	10° 54′
,, 17 ..	20° 57′E	2° 28′	304° 59′
,, 22 ..	19° 24′E	1° 52′	239° 5′
,, 27 ..	17° 41′E	1° 14′	173° 11′

THE MOON:—

Date.	Phases.	H. M.
Nov. 4..	☾ Last Quarter	9 38 p.m.
,, 13..	● New Moon	2 18 a.m.
,, 20..	☽ First Quarter	5 29 p.m.
,, 27..	○ Full Moon	8 52 a.m.
Nov. 9..	Apogee	5 24 p.m.
,, 25	Perigee	1 30 p m

ECLIPSE OF THE MOON.—There will be a total eclipse of the Moon on the morning of the 27th, but it is only partly visible in this country, as the Moon sets shortly after contact with the shadow. A few details are given below:—

First Contact with the Fenumbra, Nov. 27, 6.12 a.m.
First Contact with the Shadow .. ,, 7.11 a.m.
Beginning of Total Phase .. .. ,, 8.14 a.m.
Magnitude of the Eclipse (Moon's diameter = 1) 1·372.
At Greenwich the Moon sets at .. .. 7.34 a.m.

OCCULTATIONS.—The following are the principal occultations visible from Greenwich:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point, E.	Mean Time.	Angle from N. point, E.
			P.M.		P.M.	
Nov. 2	A Geminorum	5·0	10.47	37°	11.27	315°
,, 22	30 Piscium ..	4·7	6.33	36°	7.40	256°
,, 22	33 Piscium ..	4·6	8.28	83°	9.29	209°
,, 25	38 Arietis ..	5·2	6.27	103°	7.13	198°
,, 28	132 Tauri ..	5·1	7.43	44°	8.32	288°

THE PLANETS.—Mercury (Nov. 1, R.A. 13h 20m; Dec. S. 6° 8′. Nov. 30, R.A. 16h 16m; Dec. S. 21° 56′) is situated in Virgo and well visible shortly before sunrise during the early part of the month. On the 6th the planet rises about 5.30 a.m.

Venus (Nov. 1, R.A. 17h 30m; Dec. S. 25° 59′. Nov. 30, R.A. 19h 50m; Dec. S. 23° 57′) is an evening star setting at 6.23 p.m. on the 1st and at 7.4 p.m. on the 30th. Towards the end of the month, as the planet approaches greatest elongation, she becomes a conspicuous object and easy of observation before sunset. As seen in the telescope the planet appears at half-moon phase, the diameter of the disc being 22″.

Mars (Nov. 1, R.A. 23h 48m; Dec. S. 3° 34′. Nov. 30, R.A. 0h 13m; Dec. N. 0° 51′) is visible all the evening, and sets at 2.18 a.m. on the 15th. In consequence of the planet's brightness and reddish colour he forms the most conspicuous object in the evening sky looking South about 8 p.m. On account of increased distance from the Earth the planet is diminishing in brightness, the apparent diameter being now only 15″, as compared with 24″ at opposition. The latitude of the centre is −24°, thus the Southern hemisphere is inclined towards the Earth and the South Polar Cap is in an extremely favourable position for observation, thus the white portion at the pole, called the "Snow Cap," can be well seen using a magnification of about 200. Telescopic observation of the disc shows many other markings, but good conditions of seeing are requisite for distinguishing any details of the surface markings.

Jupiter (Nov. 1, R.A. 12h 17m; Dec. S. 0° 38′. Nov. 30, R.A. 12h 36m; Dec. S. 2° 37′) is visible in the mornings rising at 2.56 a.m. on the 15th.

Saturn (Nov. 1, R.A. 1h 12m; Dec. N. 4° 38′. Nov. 30, R.A. 1h 6m; Dec. N. 4° 6′) is very favourably placed for observation, being due South on the 1st at 10.29 p.m. and at 8.30 p.m. on the 30th. The planet is situated to the S.E. of the square of Pegasus and to the East of Mars, being nearly as bright as the latter planet but of different colour, Saturn being dull white whilst Mars is red. The telescopic view is splendid, as the rings and belts are readily seen even when seeing is comparatively poor. In addition to the ring, the belts on the disc and also some of the numerous satellites may be observed. The apparent diameter of the outer major and minor axes of the ring system are respectively 45″ and 8″, and we are looking on the Southern surface at an angle of 10°, so that the ring appears open. The diameter of the ball is 18″. The ring is visible in any good ordinary telescope if sufficient magnifying power be employed; the ring is visible with a power of about 50 and the belts with a power of 80. The moon appears near the planet on the 23rd.

Uranus (Nov 15, R.A. 19h 15m; Dec. S. 22° 48′) is unfavourably placed for observation on account of his great Southerly declination; the planet is situated about 2° South-East of the star ξ² Sagittarii and near the middle of the month sets about 8 p.m.

Neptune (Nov. 15, R.A. 7h 23m; Dec. N. 21° 22′) rises about 7.30 p.m. and crosses the meridian at 3.30 a.m. on the 15th. The planet is situated about half a degree South-East of the star δ Geminorum.

METEORS.—The principal meteor showers during the month are the Leonids and Andromedids:—

Date.	Radiant.		Characteristics.
	R.A.	Dec.	
	h. m.		
Nov. 14-16..	10 0	+22°	Swift, streaks. (*Great Leonid* shower.)
,, 17-23..	1 40	+43°	Very slow, trains. (Great Andromedid shower.)

Algol will be at minimum on the 3rd at 6.1 p.m., on the 20th at 10.55 p.m., and the 23rd at 7.44 p.m.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—η Cassiopeiæ 0h 43m, N. 57° 17′, mags. 3½, 7½; separation 5″·9. Binary star.

λ Arietis 1h 52m, N. 23° 6′, mags. 4, 8; separation 37″. Components white and blue; easy with power 20.

η Persei 2h 44m, N. 55° 28′, mags. 4, 8; separation 28″. The brighter component is orange, the other blue. There are also several other fainter stars very near.